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EDITORIAL

Profit, the Way to Plenty

MATHEMATICALLY there may be little difference between limitation of profits and their recapture by taxation. Politically the ideology of limitation may be preferable. Psychologically the principle of limitation is all wrong.

This is not a matter of greed vs. patriotism. Men smart enough to manage a business can figure a project through to the final penny and foresee the remnant of profit, if any, by either method. Yet to make a profit, even an evanescent profit seem unethical or illegal is to rob American enterprise of a familiar and potent tool whereby our national efficiency has been attained. To make absence of profit the criterion of patriotism is to put a premium on inefficiency, both by the purchasing agent and by the producer. It camouflages the waste of man power and materials. Waste cannot be taxed. Profits can. Profit limitation is only another phrase for the cost-plus of the last war. Those of us who witnessed its inefficiency and inflationary influence are honor-bound to protest its repetition.

As agricultural engineers our greatest opportunity to serve the cause of freedom and the American way is to instruct and inspire the farmer in ways to multiply food and fiber production per man, and to cut the cost per bushel or per bale. The more profit he makes for himself, the more he produces for the nation. No matter if his profit be taxed away, it still stands as a tangible if temporary objective. To substitute the idea of profit limitation would becloud that objective. To exempt the farmer would create a cleavage in a time when unity is all-important.

The more we can make the farmer think in terms of profit, the less he will follow the fallacy of thinking in terms of price. The more faithfully he pursues the principle of profit, the more economically and the more abundantly can he feed the civilized world.

"Rationed Scarcity or Abundant Production?"

"WHEN the American public has been told for years that America is a land of plenty, that we had such an overabundant supply of many things, including foodstuffs and factory equipment, that it was necessary to cut down production to prevent a breakdown of our economy, it is a great shock to consumers to see imposed so early in the war the beginning of a card-system for rationing of any consumers' goods, let alone foodstuffs. The economically informed person may be inclined to ask whether such rationing is a necessary and inevitable technique for distributing scarce goods to consumers, a propaganda technique to condition people to the sacrifice and regimentation that war is likely to bring, or an inefficient bureaucrat's way of distributing scarcity because of his inability to cope with the problem of achieving greater production and wider distribution of the products of mines, farms, and factories."

Thus opens the editorial in *Consumers' Research Bulletin* for May 1942, written by F. J. Schlink. Through the years Mr. Schlink has been critical of the sins and shortcomings of business and industry. He can hardly be suspected of overstating the case for business when he mentions its virtues in the concluding paragraph of his editorial, as follows:

"The suspicion is gaining ground throughout the country that the job of directing American production and distribution of goods is much too big a job to be handled successfully by any single group of men in Washington, D. C. It is too big, indeed, to be handled in any other way than by many groups of experts of high qualifications, experience, and initiative, working in all the various major industrial centers of the country — *engineering and production experts who know factories from the inside, and who have personally and successfully managed and operated functioning, complex, productive enterprises.* Such men would try to solve as many of their problems as possible by more and better *production,* not evade them by stopping production and setting up some new rationing scheme."

Though Mr. Schlink speaks largely in terms of the factory, the principles he thus summarizes and which he exemplifies in the intervening paragraphs, apply with much force to farm production. As agricultural engineers, looking to factories for the equipment and materials wherewith to implement the farmers we serve, we can largely concur in his views with respect to industry and its management.

In a war so desperate as this one, the rights of private business and individuals cannot be much considered. Neither should the exigencies of war be made an occasion for the redistribution of wealth or the exaltation of social theories. As the most effective, efficient, and adaptable agency of production, private enterprise and its management should not be obstructed, but assisted. In a war of production we dare not throw away our best production tool.

Two Chances for Re-Use

A PROMISING opportunity for agricultural engineers to save a small but worth-while tonnage of steel is in the re-use of bale ties, now used in new amounts by the light-weight pick-up balers which have come into use to meet the problem of more and better forage with less labor. Some, at least, of these balers measure the bales accurately to length, so that ties of fixed length may be used. Likewise, some ties are made with ends which simply button and unbutton. Presumably arrangements can be made to make any amount of ties in this style or its equivalent.

To salvage such ties calls only for unhooking them without damage, and straightening them sufficiently for carrying and handling on the baler. It is suggested that this can be done by stretching the wire a trifle past its elastic limit. Creation of convenient, low-cost devices for this purpose might well be an undergraduate project in departments of agricultural engineering.

More difficult will be the rust problem if bale ties are to become semipermanent farm equipment, and this is what they should be where hay is baled and fed on the same farm. Finding a coating or treatment which will not encroach on critical war materials probably will reach outside the realm of agricultural engineering, but at least we can define the requirements and assist in the testing of experimental products.

Farm tractor tires are another opportunity for re-use of critical materials. In this service, heat and abrasion are at a minimum. It should be possible to use reclaimed rubber or rubber substitutes to a degree not feasible for vehicle tires. Just as our profession cooperated with the tire industry in putting tractors on rubber, so can we cooperate in replacing rubber. Certainly this is no time to lose the extra speed and capacity of tractors with resilient tires.

AGRICULTURAL ENGINEERING

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Recent Findings in Agricultural Engineering

By R. W. Trullinger

FELLOW A.S.A.E.

WAR requirements call for increased production of most of the raw materials necessary to feed the United States and associated nations. For years the state agricultural experiment stations have been contributing to the gradual development of a mechanized agriculture which would lower the cost and increase the speed and efficiency of production and aid in improving the quality of the materials produced. The following is a summarized statement of some of their recent achievements in agricultural engineering as reported in a survey of their work during the fiscal year ended June 30, 1941:

MACHINERY AND POWER

Shortage of farm labor in the present emergency has made the further development and adaptation of labor and cost-saving mechanical farm equipment almost imperative. Greater efficiency in the use of farm power is also an important objective.

Better Use of Tractors and Power Equipment. During 1940, according to the Bureau of the Census, the value of tractors sold by manufacturers for use on farms in the United States was $202,650,132. This represents an increase of about 28 per cent in value over the previous year. The same report indicates that the total production of farm tractors of all kinds for 1940 was 283,546, an increase of more than 30 per cent over the previous year, reflected especially in the wheel types of over 30 bhp equipped with rubber tires and in the tracklaying types.

In 1941 the stations continued their efforts to increase the efficiency of tractor operations and of the power equipment used with tractors. For example, the New York (Cornell) and Minnesota stations have shown that tractor power is more economical than horsepower for most farm work, especially for such heavy draft jobs as plowing and seedbed preparation, where the total hours of use per day and per year are sufficient to fully utilize the advantages of the mechanical power. The Michigan station has shown that by proper use this advantage may be as much as 10 per cent. Four-wheel-drive power units have been applied successfully by the Idaho station to meet the field-power requirements of potato production, tests of 13 four-wheel-drive tractor units for pulling potato diggers showing that one driver can operate the digger and place sacks for pickers, thus materially reducing the labor charge. Alcohol may be made profitably for fuel-blending purposes at approximately 25c per gal, according to the Iowa station, and can be used in proportions of 5 to 12 per cent in gasoline with corresponding price increases of only 0.7 and 1.2c per gal over gasoline given an equal antiknock value by use of other antiknock agents. Its use increases the mileage per gallon and lowers operating temperature. In tractor tests the fuel consumption in both pounds per acre and gallons per acre was greater with alcohol-gasoline blends, according to the Kansas station, but with low-octane gasoline the maximum power developed was greater and thermal efficiency and work per gallon were higher at maximum load runs with the blends, due to their higher antiknock value. Tractor tests with alcohol-distillate blends showed increased power but apparently increased fuel costs.

Efforts to develop better power machinery for the planting and culture of specific crops have been continued by the stations. For example, in Louisiana sugarcane-culture methods used for the tillage of stubble cane were found both inadequate and expensive in view of current prices paid for sugar. In efforts to eliminate or decrease costly hand labor, the Louisiana station developed a two-row tractor cultivator and two-spinner cultivators for removing dirt and weeds from the top of the row. This equipment is now being put out by machinery manufacturers and is being widely used by cane growers. The station found that chiseling before planting 20 to 22 in deep with 18 in on centers increased the sugar yield 629 lb per acre. Rotary plowing also increased yields. As a result of these studies the general tendency now is toward deeper seedbed preparation in sugarcane culture.

In continuation of studies of corn-production machinery the Iowa station in cooperation with the Bureau of Agricultural Chemistry and Engineering of the U. S. Department of Agriculture showed that plowing is

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EDITOR'S NOTE: This is the complete text of the material on agricultural engineering as prepared for the 1941 annual report of the state agricultural experiment stations by the Office of Experiment Stations, U.S.D.A.; however, due to curtailment of Department printing funds, this material will appear in greatly condensed form in the official report.

the only method of primary preparation of seedbeds which is generally satisfactory, and that better work is done by 16-in than by 14-in plows. Plow jointers improve coverage of trash and crop residues. Labor and power expenditures in plowing were found to be about in proportion to depth of plowing. From plowing up to planting, in the absence of perennial weeds, the single-disk harrow produced as good results as the field cultivator. One tillage of plowed ground with tandem-disk harrow and spiketooth harrow just before planting gives generally sufficient seedbed preparation. Cultivator performance is improved by use of sweeps instead of shovels, and disk hillers were found to be the most effective equipment for covering weeds in the corn row. Early spring plowing with disking and harrowing just ahead of planting gives both higher yields of corn and higher returns per man-hour and per horsepower-hour than plowing, disking, and harrowing just ahead of planting, according to the Missouri station.

More Efficient Tillage Methods and Equipment. The stations continued studies designed to reduce the heavy power-requirement factor in tillage to a minimum commensurate with good crop production. For example, the Pennsylvania station made progress in separating the draft of a plow into the part usefully employed in tillage and the unproductive part. Tests of complete plowing implements showed that the total draft of a disk plow is only slightly more than that of a moldboard plow equipped with rolling coulters and jointers for the same amount of plowing. The moldboard plow is more efficient in the useful work of plowing, but this advantage is lost in the increased friction on the landside or other means used to hold it in position. It was also found that the maximum impact force which steel plowshares can stand without being bent is about 5,300 lb. This force was reached with an ordinary plow and tractor having a total weight of 3,190 lb, at a speed of 3 mph, the plow share bending at any higher speed when striking a solid obstruction.

Cultivating equipment for a four-row tractor unit to be used in tillage operations in summer fallow and seedbed preparation was developed by the Idaho station. This equipment features economy in material and cost of fabrication, elimination of field breakage, and satisfactory operation. Cultivation of row crops for weed control often entails serious economic losses through root injury.

Typical of work by the stations to combine weed control and root protection is that at the Mississippi station, where cultivation methods and equipment have been successfully developed which are applicable to cotton and corn.

Better Mechanical Planting and Fertilization of Field Crops. Improved stands of row crops as well as savings in cost of seed, fertilizer, and labor are primary aims of the stations. According to the Iowa station, higher yields of corn may be expected with closer row spacings, the optimum being single-stalk hills evenly spaced. While it appears that a 21-in row spacing gives the best yields, the station points out that this will require a tractor that can be adjusted to fit 21-in rows, a special planter, and a special harvester. A 30-in row spacing gives an appreciable increase in yield over the standard 42-in spacing and the necessary equipment has been developed, but a single-row harvester will be necessary. A grain-drill arrangement for planting peas and beans with side-band fertilizer placement and hoe openers for the seed so spaced as to avoid fouling, and a corn planter having three seed hoppers on a grain-drill frame with provision for sideband fertilizer placement, have been developed by the New York (Cornell) station.

Cotton planters equipped with shovel seed-furrow openers should have narrow shovels about 1 in wide, according to the Texas station. Press wheels used before and after covering the cotton seed gave best results when a knife and a wide furrow opener were used. The station also found that disturbing the soil under the cottonseed to apply fertilizer produced lower stands than where the fertilizer was applied to the side. Planter attachments for side placement below the seed level are now being put out by manufacturers.

Mechanical Harvesting. During 1940 farmers purchased over $43,000,000 worth of harvesting machinery, according to the Bureau of the Census. This included not only small grain, corn, and potato harvesters but various types of haying machinery. Many new harvesting problems were encountered by the stations. There was again a marked increase in the use on farms of small combines, especially those having a width of cut of 6 ft and under. These smaller size combines are proving economical and satisfactory in operation, according to the Missouri station, which found that the cost of combining is affected most by the total acreages harvested per year. Records of fifty-three 5-ft machines showed costs of 78c per acre for between 400 and 450 acres cut per year and $2.19 per acre for less than 100 acres per year.

Potato harvesting, especially where the crop is large, has presented a problem of lifting the potatoes from the ground into the wagon without injury, as nearly one-third of the total labor required for producing a potato crop is expended in picking up the potatoes after they have been raised to the surface by the digger, according to the Pennsylvania station. The station developed a harvester which has been successful in eliminating this labor requirement, especially under conditions of stony soils and heavy yields, and the essential improvements are being incorporated in potato diggers now being manufactured. A conveyor for elevating potatoes has been developed by the Michigan station which saves time and labor and removes about 1.5 lb of dirt per bushel of potatoes handled.

Hay and grass curing continued to present serious problems owing to the growing need to conserve hay and forage crops to the maximum, frequently under extreme weather conditions. For example, in Pennsylvania alfalfa production is curtailed owing to the difficulty of securing good-quality hay under the unfavorable weather conditions that frequently prevail during the first and third cuttings. The Pennsylvania station has demonstrated that dehydration enables the production of high-quality hay regardless of weather. The feeding value of dehydrated alfalfa and mixed hays for dairy cattle has been found superior to corresponding sun-cured crops. With hay having an initial moisture content of 75 per cent, dehydrators at present available when properly operated can produce a ton of hay having 12 per cent moisture by using a little over $\frac{1}{3}$ ton of coal or about 62 gal of fuel oil. Apparently the best opportunity to reduce the cost of artificial dehydration lies in the greater use of preliminary field drying, as hay dried to about 60 per cent initial moisture content requires only 1/6 ton of coal or 29 gal of fuel oil to dehydrate it artificially to the desired moisture content.

Where artificial dehydration of hay is economically out of the question and weather conditions are usually unfavorable, the conservation of hay becomes more difficult. For example, in Mississippi approximately 20 per cent of the annual hay crop is lost and 50 per cent of the remainder is damaged in quality during the process of field curing. The Mississippi station has just completed a 10-year study of

this problem, which has resulted in the development of mechanical methods and equipment used in hay curing that have materially lowered these losses and permit the satisfactory curing of alfalfa, Johnson grass, and soybean hays between daylight and dark. It has been found that the practice of double windrowing hay favors transpiration and water loss, due to the fact that lowering of temperature in the windrow is accompanied by reopening of the stomata in the leaves. Crushing the stems of large-stemmed hays such as soybean and Johnson grass also expedited drying.

As a result of these findings, windrowing instead of swathing is now a common practice in Mississippi, and the station has developed a hay-stem crusher which is being manufactured commercially. During the past two years hay production on Mississippi farms has increased nearly 100 per cent. In connection with the mechanization of hay handling, including direct chopping from the field and storage of chopped hay from both field and stack chopping, the Idaho station developed a modified plan of shed-roof dairy barn based on the ratio of 1 to 1 between chopped hay and loafing space for the animals which would meet the added cost of chopped hay by better utilization of the hay and saving in labor of hay handling.

The stations continued studies on the harvesting and storage of grass silage as a forage-conservation measure of special importance in connection with the meeting of emergency production goals regardless of weather conditions. For example, the New Jersey station showed the necessity for more adequate reinforcing of concrete silos and for more effective protective coatings for silo interiors. Promising results were obtained with varnishes and synthetic resin with wood oil vehicles, high-melting asphalts, coal tars, and cement washes. It was found possible to minimize vertical joint leakage by prestressing the hoops. Foundation drains were also found effective in reducing side-wall leakage. Cost-of-production studies showed that legume and grass crops for silage can be produced $2.50 per ton cheaper than corn silage. A vertical silage elevator has been developed which shows promise of low power demand.

The mechanical harvesting of corn has developed problems which are intensified by the trend of increasing corn yields and higher operating speeds of farm machinery. These increases demand a faster husker action, and investigations were made by the Iowa station and the Bureau of Agricultural Chemistry and Engineering of several roll type husking mechanisms to determine husking effectiveness as well as corn loss. Rotation of corn ears is important for effective husking, and the use of an ear forwarder set at an angle with the roll axis was found to be a satisfactory method of obtaining this rotation. The spiral type husking roll was found superior to smooth cylindrical rolls. Roll speeds from 250 to 700 rpm had no significant effects on the husking efficiency of a roll mechanism, but speeds below 200 rpm reduced the efficiency.

Weed-Control Equipment. The control of noxious weeds is a problem constantly confronting farmers, and experiment stations in all sections of the country have undertaken to develop control measures adapted to their respective state conditions. For example, the Wyoming station developed a hand-operated and two motor-driven weed burners, all producing a very hot spreading flame, from such cheap fuels as used crankcase oil, refinery discard, light crude oils, and furnace oil. This equipment was more effective in weed eradication and cheaper in operation than chemical killers.

Spraying and Fumigating Equipment. The Ohio and Michigan stations have cooperated with the Bureau of Agricultural Chemistry and Engineering in the development of an oil-fired, vapor-cleaning unit for use for vapor spraying of insecticides and fungicides. Sulfurs seemed to be particularly well adapted to application by the vapor sprayer, but free nicotine, phenothiazine, and bordeaux mixtures suffered deterioration. The Ohio station in cooperation with the Bureau of Entomology and Plant Quarantine (U.S.D.A.) developed equipment for burning sulfur in empty greenhouses and in mushroom houses for the destruction of mites and insects. Tests of the build-up of sulfur dioxide concentration showed that concentrations lethal to red spiders and their eggs were secured at all points where test leaves infested with these pests were placed. It appears that 3 lb of sulfur per 1,000 cu ft of space should produce a concentration of sulfur dioxide sufficient to kill all forms of mite and insect life. An insecticide-dispersing machine was developed by the Illinois station that was found useful for the destruction of flies and other insects in dairy barns and milk houses.

Orchard Heaters. Where fruit crops that are susceptible to injury by late frosts are grown, the experiment stations are constantly confronted by the problem of devising ways and means of preventing such injury and at the same time avoiding creation of nuisances. The smoke nuisance was minimized by the California station by keeping the burning rates of orchard heaters within the proper range for the type of heater used, by cleaning stacks and covers regularly, by the use of tight-fitting covers, and by regulation as soon as possible after lighting. Automatic draft regulators superior to the ordinary regulator in control of the burning rate were developed. A heater was developed which is specially designed for burning residual or pour-back oil. Provision was also made to return part of the hot stack gases to the bowl and thereby improve completeness of combustion.

EROSION AND RUN-OFF CONTROL METHODS AND EQUIPMENT

Forty-two states have now adopted soil conservation district laws, and 619 districts have been established under these laws, including in their boundaries over 365,000,000 acres of farm lands. These facts have brought the stations problems more pressing and intricate than ever before in the development of methods and equipment for the conservation of land and water resources for agricultural purposes. Practically all their research is in one way or another cooperative with the U. S. Soil Conservation Service. As in the past, most of this research is organized on the basis of the conservation needs of soils by type areas and climatic conditions so far as federal-state cooperation is concerned, this having been found an effective and efficient procedure.

Studies on soil and water losses from cropland in that part of the Tennessee River Valley lying in Virginia was conducted by the Virginia station in cooperation with the Soil Conservation Service (U.S.D.A.) and the Tennessee Valley Authority which showed that open-cultivated cropping causes excessive losses of soil and water on slopes above 10 per cent. The critical slope for small grain is probably above 25 per cent, and for a three-year rotation of corn, wheat, and clover on Dunmore silt loam about 15 per cent. Replacement by sodium nitrate of nitrogen removed by erosion during this rotation would range in cost from about 35c per acre on a 5 per cent slope to nearly $12 per acre on a 25 per cent slope. Phosphorus replacement by superphosphate would cost about 22c per acre on a 5 per cent slope and nearly $6 per acre on steep land. Experiments on permanent pasture land showed an 85

per cent increase in desirable vegetation on Dunmore soil resulting from superphosphate applications accompanied by a 64 per cent decrease in soil loss. Similar studies in northwest Texas on Miles, Abilene, and associated soils, subject to an average annual rainfall of between 20 and 21 in, showed that level terraces having open ends were much more efficient in conserving water than terraces with 3-in slope per 100 ft along the terrace and caused an appreciable increase in crop yield, according to the Texas station working in cooperation with the Soil Conservation Service. Level terraces with ends closed so as to hold all the rainwater gave an average increase in crop returns for 12 years of $6.21 per acre. Diversion of the run-off water from a 1,200-acre watershed to a 120-acre terrace system increased the water available to crops about 16 per cent, resulting in a marked gain in crop yields. Solid contour listing of native grass pasture resulted in deep penetration of moisture, an increase in available moisture, and a three-fold increase in forage production. It appears that a close relationship exists between the available water in the soil at planting time and the yield of lint cotton. Seasonal rainfall apparently is of less importance than moisture stored in the soil prior to planting time.

In an effort to conserve irrigation water and increase the efficiency of its use, the experiment stations in the irrigated states have continued studies of water conveyance, delivery, and application. For example, it has been found by the Utah station that the cost of lining irrigation canals must be justified largely, if not entirely, by the value of the water saved. The station has reduced the results of an analytical study of the costs and water savings involved in lining canals with concrete to a formula for estimating justifiable costs per square foot of lining. In the cases of seven out of eight canal sections studied, the justifiable cost of lining to save water was well above first cost of lining and ranged from 2.4 to 8.9c per sq ft.

In water-application studies the California station demonstrated that a nearly uniform application is possible with proper sprinkler patterns and optimum spacing of sprinklers. Approximately conical sprinkler patterns produce a uniform application when the sprinklers are spaced not farther apart than 55 to 60 per cent of the diameter covered. The degree of uniformity obtainable decreases with increase of sprinkler spacing for all spacings greater than 50 per cent of the diameter covered. For spacings greater than 50 per cent and with equivalent areas covered by each sprinkler, a more uniform application can be obtained with an equilateral triangular arrangement of sprinklers than with a square or rectangular arrangement. There is a rapid evaporation loss of water from water-logged soils when water tables are as close as 1 ft from the surface, according to the California station, but the loss decreases very rapidly with increase of depth of water table and becomes almost negligible from a water table 5 ft deep.

RURAL ELECTRIFICATION

Consumers of Rural Electrification Administration-financed power systems used 568,190,394 kw-hr of electricity during the fiscal year 1941 as compared with 311,479,005 kw-hr for the previous year. The number of miles of line actually in operation grew from 232,978 to 307,590. More than 80 per cent of the consumers were farms. This has meant a rapid increase in the number of farms receiving central-station electric service for the first time. To keep pace with the Rural Electrification Administration program, the stations and the Department of Agriculture continued their investigations to increase the efficient use of electricity in farming operations. The Idaho station reported that 64.2 per cent of all occupied farms in Idaho now have electric service.

Farm Freezing Units. There has been a wide demand for the development of farm freezing units and frozen-locker storages for farms. A top-opening freezer cabinet has been developed by the Indiana station, and plans are now available from the Idaho station for a 20-cu ft lift top box and a 45-cu ft reach in two temperature box equipped with three doors and a combination shelf-type cooling coil for the frozen storage section. Plans are also available for a farm-made walk-in cooler providing a frozen-storage compartment.

Electric Pig and Lamb Brooders. In order to reduce the hazards to baby pigs and lambs the stations have continued studies of electric brooders for these young animals. The Washington station has developed a successful pig brooder which is built into the corner of the pen and is heated by a 150-w electric light bulb in a reflector in the top of the brooder, and also a successful lamb brooder built against a side of the pen and heated by 60-w bulbs placed 2 ft apart in a hemicylindrical tin-plate reflector. A smaller portable brooder has been developed for use in individual lambing pens. Plans for a successful homemade electric-lamp pig brooder have been made available to farmers by the Oregon station, and the Alabama station has developed a homemade lamp brooder adapted for 50 or fewer baby chicks.

Electricity in Dairy Farming. Cleanliness in the handling of dairy products offers a continuous stream of problems to the stations. The Indiana station has demonstrated that electric water heaters of 3 to 15-gal capacity are practical for use on Indiana dairy farms producing bulk milk. The most important single efficiency factor in the use of such heaters has proved to be that of insulation. Tank heaters have shown an average efficiency of 77.7 per cent as compared with 62.8 per cent for immersion heaters operated in uninsulated pails. The California station has demonstrated that electrically operated dairy-equipment sterilizers are practical and have certain advantages over other types. It appears that the self-contained sterilizer with the steam generator and sterilizing cabinet as one unit is the most economical in both initial and operating costs, although it does not supply controlled steam.

Milk cooling is an everpresent problem which varies with climate and locality. The Kansas station has demonstrated that cold air is practically worthless to cool milk in 10-gal cans, but that if water having a temperature of 60 F or below is available, it can be used satisfactorily as a cooling medium for grade B milk. Stirring the milk three times the first hour doubled the rate of cooling in well water, and agitating the cooling water increased it six times. The cost of cooling milk was found to be cheapest when using the wet-storage method and most expensive when using ice. Mechanical refrigeration operated by electric motor was found to be the most satisfactory for milk cooling. In studies aimed at the development of one-can electric milk coolers, the Pennsylvania station demonstrated that the cost of maintaining the water bath at an average temperature of 35 F for 21 consecutive days could be reduced to approximately 1.02 kw-hr per day. It was found that the available refrigeration in the form of ice bank on the coil does not become effective until after the third hour. When

the water bath is in motion, the milk cools more uniformly in the first hour. At least 3 in of insulation is required in the walls of a milk-cooling cabinet for economical operation.

In a study of dairy-stable lighting it was demonstrated by the Maryland station in cooperation with the Bureau of Agricultural Chemistry and Engineering that whereas many farmers are satisfied with about 1 ft-c (foot-candle) of light at the milking point, higher levels of illumination can be easily obtained with efficient use of 60 or 100-w lamps. The studies showed need for 2 ft-c or more of illumination for close readings of the ordinary dairy scale. While 0.3 to 0.5 ft-c is used in the ordinary feed alley, this is inadequate to enable one to distinguish the tines of a pitchfork on top of a clump of hay. It was found that adequate light at the rear of the cow is most important. Plans for more adequate lighting have been made available.

Electric Fencing. Electric fencing, while both effective and economical, offers hazards which have required research. According to the Pennsylvania station all the older animals carefully avoid a second contact with either battery-operated fences or those using alternating current. Heifers without previous training usually break through once but are held satisfactorily after being returned to the same enclosure. Young pigs perform in about the same manner.

FARM STRUCTURES

Similar to the need for better mechanical methods and machinery is the need for better structures on farms to expedite and improve production, particularly in the face of farm-labor shortage and shortage of structural materials. The stations have therefore continued active research into better utilization of locally obtainable building material.

Better Farm Homes. Improved low-cost farm homes have been developed by the Arkansas station through the utilization of farm materials and resources. The station has found that there are large supplies of materials suitable for farm-house construction, such as stone, sand, gravel, logs, poles, low-grade lumber, and various forms of stabilized earth, which can make satisfactory structures without interfering with defense needs. A study of 200 cases showed that the farm was able to contribute an average of about 75 per cent of the labor needed, together with sufficient materials to make the noncash contribution slightly more than one-half the total house value. On this basis a new type of farm-home construction has been developed by the station in cooperation with the U. S. Department of Commerce which utilizes rough-sawn, uncured low-grade oak 2x4 material for the principal house construction. Cash expenditures amount to about $175 for purchased material and $250 for utilities and equipment, or a total of $425 for a four-room house of good quality. All other materials, including principally 11,000 board feet of lumber, are taken from the farm. Plans for three other even lower cost farm houses have been developed by the station.

Significant progress in the development of the use of cellulose and concrete as a mixture for building materials such as roofing, siding, and shingles has been reported by the Mississippi station. Special emphasis has been placed on the use of cotton for this purpose. A successful vibrating method and equipment have been developed which effect an intimate contact between the concrete and the cotton fibers, expel air bubbles, and provide good setting conditions for the cement. The use of sand up to a 1 to 1 mixture with cement produces a good grade of shingle 3/8 of an inch thick and weighing about 360 pounds per square.

Poultry-Production Structures. At the Mississippi station range shelters have been made from peeled pine poles and from sawn lumber large enough to accommodate 60 pullets to laying age or 100 broilers to market age. The estimated cost of the pole structure with a roof covering of sacks treated with a cement-lime mixture is $1.94, as compared with $14.06 for a sawed lumber shelter with corrugated metal roof. A portable range shelter with galvanized iron roof has been perfected by the Ohio station which accommodates from 100 to 125 pullets and may be moved on skids or by truck. The station also has developed a new portable colony brooder house in which it has been found that the weight of a 10x12-ft structure may be reduced by 500 lb by use of corrugated-iron roofing and siding instead of lumber.

Crop Storages. In view not only of defense needs but of the maintenance of ever-normal-granary conditions the stations have devoted considerable effort to the development of efficient crop storages. Typical of the grain-storage work is that at the North Dakota station where, in cooperation with four bureaus of the Department of Agriculture and three other stations, numerous types of bin construction and ventilation have been under investigation for several years. It has been found at this station and at the Kansas, Illinois, and Maryland stations that atmospheric conditions and bin size are the most important factors influencing the temperature of dry wheat. Ventilation is the most effective method of dissipating heat generated in the wheat mass. Horizontal ventilation flues were more effective than vertical flues, but no form of natural ventilation secured and maintained a low enough moisture content in wheat to prevent spoilage under North Dakota conditions. Forced ventilation through a large air drum in the center of the wheat mass was effective when a centrifugal fan was used 1 hr each dry day to a total of 24 hr of operation. The North Dakota station also has developed a wheat drier which dries 1,000 bu of wheat from 15.1 to 13.45 per cent moisture content in 24 hr of intermittent drying. This forced ventilating system requires a perforated metal floor, an air drum in the center of the grain, and a centrifugal fan. In Kansas no ventilation is needed for grain containing 12 per cent moisture, according to the Kansas Station. For damper grains ventilation methods were effective in the order, (1) power fans, (2) wind-pressure cowls, and (3) wind-suction cupolas.

Washing potatoes increases their tendency to rot, whereas drying and cooling by means of bunker fans helps to prevent rotting, according to the Louisiana station. A relatively low-cost and efficient bunker-fan unit for precooling and drying potatoes has been developed for use in shipping cars particularly. A more thorough drying results when bunker-fan units are operated while the car is being loaded and before icing the bunkers, and greater moisture loss occurs from crates than from sacks. The potato temperature should not go below 55 F, when shipping under standard ventilation. A small farm-type potato storage has been developed by the North Dakota station which incorporates features for improved methods of handling and management throughout the storage season. Electric heaters maintain curing and storage temperatures for sweetpotatoes uniformly throughout the storage house and reduce shrinking and rotting to a minimum, according to the South Carolina station.

Farm Machinery Suitable for Southern Farms

By I. F. Reed
MEMBER A.S.A.E.

IN PLANNING or suggesting a machinery program for an area, it is necessary to have a thorough understanding of the conditions in that area if the resulting plan is to be practical. A farm machinery program for southern farms includes a multitude of conditions as to types of agricultural practices, size of farm units, climatic conditions, etc. This brief discourse will therefore be confined to a program for the smaller units, attempting to show how greater efficiency may be obtained from the labor and power available, and enumerating some of the steps that may be taken to develop these smaller units.

There are about 231,000 farms in Alabama, of which 84,000 are one-mule units. If this same ratio applies also in Georgia, Tennessee, Mississippi, Arkansas, Louisiana, Kentucky, and Oklahoma, we have about 1,783,000 farms of which 650,000 are one-mule units. Many of the remaining 1,130,000 farms are made up of two or more one-mule units operating under one management and hence classed by the Bureau of the Census as larger units. This group, comprising one-third to two-fifths of the farmers of the South, has been woefully neglected by agricultural engineers. The consensus of the profession seemingly has been that the power available to these farmers so limited their operations that there was little that engineers could do to help. The feeling that the larger farm units offered problems more in keeping with the dignity of the profession, and on which more striking progress could be shown, has limited the studies largely to those of the larger type equipment. But we are now coming to realize that because of the types of crops, the topography, and the labor available, one and two-mule units must figure largely in southern agriculture for years to come.

Consider for a moment the trend in terracing methods and equipment. Early terraces were thrown up with a moldboard plow alone or in conjunction with a V drag or ditcher. With the advent of soil conservation programs, especially designed terracing units were introduced and extensively recommended. The most commonly recommended equipment that might be farmer owned was the V drag requiring two to four mules and tractor-drawn standard or vertical disk plows. Revised recommendations, however, include building terraces with plows and slip scrapers, a method within the capabilities of all farmers.

The one-mule farmer must use a small plow and a small slip scraper, but he can make a good terrace and do most of the work during slack times. This means on many farms the difference between terracing and not terracing, as it may not be possible for the operator to pay the cost of having the work done with custom units. The light-weight V drag shown in Fig. 1 and a small plow can also be used effectively. This type of drag can be made on most any farm at a very low cost. The handles allow the operator to control its work effectively and only one mule is required to pull it. A terrace of the Nichols type but smaller than that usually recommended, can be thrown up with this drag and a plow in about one-half the time the same man and mule would require using a slip scraper. Proper maintenance of the terraces with a plow and V drag should develop them into full-size Nichols terraces in two to three

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Fig. 1 (Upper left) Light-weight V drag in use. Rocks are used to furnish necessary weight. The handles enable the operator to control the throw of the soil and the load on the mule • Fig. 2 (Upper right) One-mule, single-row stalk cutter designed especially for use on the small farms of the Southeast • Fig. 3 (Lower left) A one-mule moldboard plow equipped with a jointer • Fig. 4 (Lower right) Planter designed to open beds or furrows and to plant in one operation; especially suitable for peanuts, corn, or any other crop planted in a furrow

years. Thus the slip scraper and V drag bring terracing within the reach of all classes of farmers.

So much for the recent trend in development of terracing equipment for the small farm units. Now what can be done to help produce crops more efficiently? From the soil conservation standpoint, the farmer must prevent erosion and should raise soil-building crops. This brings up the problem of turning under a green manure crop with his one-mule plows having 6, 7, or under extremely favorable conditions, 9-in bottoms.

Of a number of attachments tried, two show promise of doing the job satisfactorily. They are a small coulter with one wire, and a jointer. The small coulter cuts through the debris, and the wire helps to pull the cover crop under the turning furrow slice. This helps considerably but does not equal the coverage job that can be done with the same plow equipped with a jointer alone. Under many conditions the coulter tends to lift the plow out of the ground. The jointer used, as shown in Fig. 3, does not have this tendency. Clean plowing obtained with a jointer on a 7-in plow for turning under a moderate growth of Austrian peas, reduced the number of operations necessary for killing the cover crop. The jointer will cost $3 to $4, about one-fourth the cost of the small plow, but its cost will soon be offset by the labor saved and yields will be increased by getting crops planted on time.

THE SINGLE-ROW STALK CUTTER WAS DEVELOPED TO HANDLE A MAJOR PROBLEM ON SMALL FARMS

Cutting or breaking cotton or corn stalks ahead of seedbed preparation operations has been a major problem on many small farms. The one-mule, single-row stalk cutter shown in Fig. 2 has been developed to handle this job. This unit can be built by almost any crossroads blacksmith and has been found to be very effective. It follows the row without guidance from the operator, so that the handles are needed only to keep the cutter from tipping when one end of a blade strikes a rock or other obstruction.

Labor-saving equipment is available for most other crop production operations as well as for terracing and turning over soil building crops. Bedding cotton or peanut land with small buster, or straddle-row, double-beam, one-mule cultivators, instead of using two or four furrows with scooter plow, will increase the output per man. Making low beds that do not have to be dragged down at planting time reduces the work of both bedding and preparing for planting. Many planters for corn and cotton can be equipped with fertilizer attachments so that one man can perform these two operations at once. Some operators complain that these combination units are hard to handle, but they should consider that they are doing the work requiring two men when individual machines are used. They can afford to go a little slower.

Cultivation may be speeded up markedly by the use of weeders and straddle-row cultivators. The weeder covers several times the acreage per hour possible with a plow stock equipped with a scooter or scooter and scraper. It will destroy grasses and weeds coming from small seeds and, if the row is in a slight depression, will roll some soil into the row and cover small grass and weeds. The weeder can usually be profitably used two or three times over cotton before it is chopped to a stand. If labor is scarce, one man with a weeder and mule can continue going over the unchopped areas every few days crosswise of the row until the chopping crew can get to it. Tests made near Prattville, Ala., and reported in U.S.D.A. Circular No. 540, "Cotton-Tillage Studies on Red Bay Sandy Loam," show that delaying chopping until the cotton is 8 to 12 in high did not reduce the yields, provided the weeds were kept down by using the weeder three to five times crosswise of the rows. This then gives the small farmer a way to lengthen his chopping season and thus increase the acreage he can handle with the crew available.

The one-mule, straddle-row cultivators are made by several companies. They operate on the same principle as the two-mule, single-row cultivators but are lighter and usually are equipped with only one shovel shank for each beam. They enable the operator to cultivate two furrows at a trip instead of one, as when a single plow stock is used, and permit doing a better job. It is possible to see exactly what is being done, and should be easier to operate as the two beams can be balanced against each other instead of the operator having to hold a single shovel in place. Thus the straddle-row cultivators make possible a better job of cultivation with about half the labor required when using plow stocks.

Harvesting corn and cotton are still hand jobs for the small farmers. This, however, has never been a problem as they have always had time to harvest more acreage than they could produce. Corn harvesting by hand can be speeded up on many southern farms by having the laborers throw the ears directly into a wagon instead of picking into cotton sacks or throwing on piles.

Winter legumes and small grains should be planted with drills whenever at all possible, two rows per middle for the legumes and three rows for the grain crops when following row crops. Drilling usually produces earlier and better stands. If no drill is available, the seed must be broadcast and covered with a cultivator or scratcher. The present trend in harvesting grain crops is toward the use of combines, small farmers hiring custom units. The availability of a combine should be assured before grain crops to be harvested for grain are planted.

A RECENT DEVELOPMENT IN EQUIPMENT TO AID FARMERS IN PEANUT PRODUCTION

A recent development to aid farmers using one-mule equipment in producing peanuts is the method advanced by J. P. Wilson, superintendent of the Wiregrass Substation of the Alabama Agricultural Experiment Station. In this method the bed for the peanut row is thrown up on the fertilizer. The planter is equipped with a large shovel which opens the bed ahead of the planting mechanism. Thus, opening the bed and planting become one operation instead of requiring two trips per row. This required the development of a special planter (Fig. 4). One manufacturer was ready to go into production on this planter so as to have it available to farmers in less than six months after the experimental model was completed, but was prevented by priorities on materials. It is adapted to planting peanuts, corn, and other crops that are normally planted in a water furrow. Mr. Wilson's method of producing peanuts includes the use of a weeder for the first three or four cultivations. The weeder is particularly effective in this arrangement as it rolls soil into the row and covers small weeds or grass. One-mule, straddle-row cultivators are used for the last cultivations. The number of cultivations necessary depends upon weed growth.

Here we are directing thought and effort to saving time and labor. It is reasonable to ask what we are to do with this farm labor if the work required for crop production is reduced. This would have been an important consideration in the past, but the problem now is not what to do with surplus labor available to farms but how to reduce the labor peaks on the farms so as to handle the jobs with the labor obtainable, usually the labor on the farm. Labor

released during off-peak periods can be used for production of additional food and feed crops and for upkeep of the place. This is not the time and place to try to set forth the economic situation that has brought this about. The condition exists. Agricultural engineers are concerned with helping farmers to produce in spite of this apparent labor shortage so as to make us stronger in the war and to enable us in the near future to help feed the world. Therefore, the present trend toward mechanization of small farms is not to "freeze out" labor but is an attempt to make the best use of the labor available.

The preceding discussion sets forth developments in equipment methods for farmers using one-mule equipment. A machinery program for this group, then, is the bringing together of this better equipment and methods of use. That is, to use a plow with slip scraper or V drag for terracing; a plow equipped with coulter and wire or a jointer for turning cover crop or land where there is trash on the surface; small busters or cultivators equipped for bedding; an efficient planter with fertilizer attachment or opening shovel for planting corn, cotton, or peanuts; weeders and straddle-row cultivators; drills for planting grains and winter legumes; and unless other suitable equipment is available, a combine on custom basis for harvesting grains. There may be instances where the labor has trouble handling the recommended equipment, planters with fertilizer attachments or plows with jointer, for example. This is no reason for condemning the equipment, as in most instances it is due to prejudice or lack of ability of the individual. The equipment for the most part has been designed for the job and with moderate care will function satisfactorily.

Now just a few words about machinery for the larger farm units. Equipment for two and three-mule units will be similar to that for one-mule units. Larger plows and other equipment may be used, but the general procedure will be the same. Each farm unit in the class of four-mule or larger offers a problem in itself. The first decision is whether to use mules or tractors for power. This decision should be influenced by the labor and supervision available. Many failures of tractors and tractor equipment are due to lack of mechanical information on the part of the persons responsible for their operation. It must be remembered that this intricate machine, made as foolproof as possible, still needs definite care.

It must be realized also by many of us in this area that operators of mechanical farm equipment in many regions have as much or more mechanical knowledge than the better service mechanics of many parts of the South. The problem of working out a machinery program for these larger farm units is simplified by the fact that improved equipment has been developed to do the farm jobs effectively and is available in sizes adapted to the range of power units. Publications setting forth the economics of various sizes of units and giving instructions for use of different types of equipment are available.

As engineers, we are prone to be prejudiced in favor of mechanization in agriculture. We must be very careful in our recommendations. We must think not only of what is to happen now but must have in mind the future of our farmers and southern agriculture. Dean Funchess of the Alabama Polytechnic Institute, has said: "Many farmers are trading in their mules and mule equipment on tractors and going along nicely for a few years until the tractor needs replacing. When that day comes, they will have no mules to trade in, and many will have made no provision for replacement. Those farmers will be sunk." He was referring to one type of farmer that we will have to work with. We must keep this practical viewpoint in mind in all of our studies and in recommending machinery programs for individuals or groups of farmers.

Undoubtedly the trend is toward larger farm units. That means the use of tractors, tractor-mounted equipment, combines, etc. It seems that agricultural engineers can be of most help to southern agriculture by developing equipment and methods to promote this trend, since the only way a farmer can have the more abundant life is to have an income large enough to permit purchase of a better home and home equipment. The gross income from small southern farm units is too low to allow this.

A Castor Bean Sheller

By M. A. Sharp
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SINCE the development of the small castor bean sheller described on page 11 of AGRICULTURAL ENGINEERING for January 1942, H. A. Arnold has constructed a similar machine with a capacity of about six bushels of shelled beans per hour. This we consider adequate for individual farm use under present harvesting conditions, and it should fit into the current farm production program very well.

This sheller operates on the same principle as the small machine previously described. The rubber-faced disks are 12 in in diameter and rotate at 525 rpm. No stop bar or rings as used around the central feed opening in the stationary disk of the small machine are necessary on this one, but V grooves about 1/16 in wide in the rubber disks improved the efficiency slightly on varieties shelled. The 3x16-in suction fan, running at 1000 rpm, removes all hulls, immature beans, and dust. A ½-hp electric motor is used.

Several varieties of beans have been shelled, and results have in all cases been satisfactory. With U. S. Nos. 4 and 7, on which most tests have been run, 99.5 per cent of the beans are shelled clean and without injury, at one pass. The beans must be thoroughly dry before shelling. Data indicate that the capacity is proportional to the area of the disks, and 24-in disks should shell at least 25 bu per hr.

This machine has been developed as a cooperative project between the Tennessee Agricultural Experiment Station and the Tennessee Valley Authority. A bulletin describing its construction and operation is now in press and will be available soon.

Author: Head, agricultural engineering department, University of Tennessee.

A farm-size castor bean sheller developed by H. A. Arnold, agricultural engineer, Tennessee Agricultural Experiment Station, in cooperation with agricultural engineers of the Tennessee Valley Authority

A Short Method of Determining Volume of Run-off from Water-Stage Recorder Charts

By T. L. Copley

THE NEED for a short method of chart reading in determining the volume of run-off from experimental areas has been evident for some time. The present method used is a rather lengthy and tedious procedure, and where the run-off from many areas is to be calculated, the time required may become such a problem as to limit materially the number of studies undertaken.

The method commonly used consists of breaking the area under the run-off graph into vertical intervals, then multiplying the average discharge rate for each interval by the duration, and summing up the interval discharge volumes for the total discharge. This procedure consists of the following steps in about the order given: (1) Marking off the points where breaks in the water-stage graph occur or the allowable stage variation is equaled, (2) tabulating the time of each break, in chronological order, and the time interval between these points, (3) tabulating the gage height and discharge rate at each point and the average discharge rate for the interval, (4) computing the discharge or depth for each interval, and (5) finally summing up these for the total. The tediousness and amount of time required in this procedure is obvious.

A new and much shorter method has been developed that has proved quite accurate on both rectangular and circular charts, and appears to fill the need where only volume of run-off is to be determined. It also provides a check where the conventional method is necessary in determining rates of run-off and in the preparation of hydrographs.

By the new method the area under the run-off graph is divided into horizontal rather than vertical intervals, and the discharge rate for each interval is multiplied by the average length or duration of the strip, to secure the interval and total discharge.

In using this method it is necessary first to determine the height of the horizontal interval to be used. For charts with a 5/12 gage height ratio for small plots, a 0.02-ft stage is suggested for accurate reading, since this will be a small division on the chart. The narrower the strip, the greater the accuracy obtained, and also the greater the amount of calculation. Conversely, the wider the strip, the greater the chance for error, but the less the amount of calculation. A few trials with several types of graphs on a given type of chart will indicate the best height of interval.

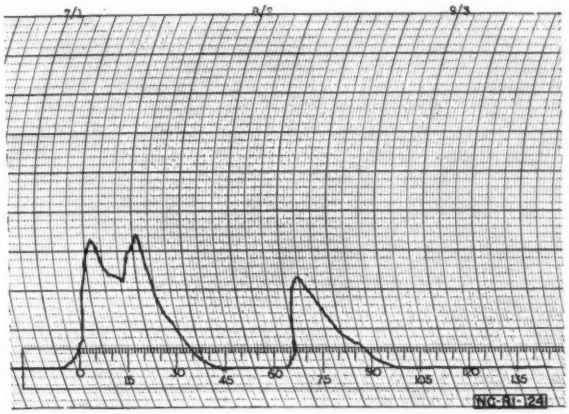


Fig. 2 A portion of a recorder chart showing the pen trace produced by an actual rain. The scale shown represents one devised from transparent material and graduated in minutes similar to the chart. The duration of each horizontal section is measured in minutes and recorded on the form shown as Fig. 1

The next step is to prepare a suitable form, or work sheet, similar to the accompanying sample (Fig. 1). Column 1 of this form should show the gage height interval. This may be represented either by the top and bottom points or the middle point of each strip. Column 2 should show the increment discharge rate for each interval. Column 3 is for the duration of each interval, and Column 4 for the calculated interval discharge. Additional duration and volume columns may be added for as many experimental areas as need to be considered together.

The discharge rate for each head interval is derived from the standard rating table for the flume used, and is the difference between the total discharge at the gage heights represented by the top and bottom edges of the interval in question. For example, the discharge increment for the section of head between 0.52 and 0.54 ft of the accompanying *(Continued on page 192)*

Form NC-RI-17 (Rev.) RECORD OF RUNOFF (Short method of volume determination) Computed by_____ Date_____ Checked by_____ Date_____

For .8' HS flume with flat floor, rated April 1941 Experiment_____ Date of Rain_____ Amount of Rain_____

Head Interval Feet	Discharge Rate c.f.s.	Plot 1 Duration min.	Plot 1 Vol. for Time Int. cu. ft.	Plot 2 Duration min.	Plot 2 Vol. for Time Int. cu. ft.	Plot 3 Duration min.	Plot 3 Vol. for Time Int. cu. ft.	Plot 4 Duration min.	Plot 4 Vol. for Time Int. cu. ft.	Plot 5 Duration min.	Plot 5 Vol. for Time Int. cu. ft.	Plot 6 Duration min.	Plot 6 Vol. for Time Int. cu. ft.
.00-.02	.0180	120	2.2080	123	2.2710								
.02-.04	.0516	109	5.3748	94	4.8504								
.04-.06	.0756	74	5.5944	88	6.6528								
.06-.08	.1020	60	6.1200	76	7.7520								
.08-.10	.1278	53	6.7734	65	8.3070								
.10-.12	.1554	42	6.5268	53	8.2362								
.12-.14	.1776	38	6.7488	45	7.9920								
.14-.16	.210	34	7.1400	41	8.6100								
.16-.18	.240	25	6.0000	38	9.1200								
.18-.20	.264	19	5.0160	35	9.2400								
.20-.22	.300	7	2.1000	32	9.6000								
.22-.24	.324	3	1.0080	30	10.0800								
.24-.26	.366	½	.1830	28	10.2480								
.26-.28	.402			26	10.4520								
.28-.30	.432	TOTAL	60.7932	23	9.9360								
.30-.32	.476			14	6.6640								
.32-.34	.516			10	5.1600								
.34-.36	.546			6	3.2760								
.36-.38	.588			3	1.7640								
.38-.40	.618												
.40-.42	.660			TOTAL	140.1514								
.42-.44	.720												
.44-.46	.780												
.46-.48	.780												
.48-.50	.840												
.50-.52	.900												
.52-.54	1.02												
.54-.56	1.02												
.56-.58	1.08												
.58-.60	1.08												
.60-.62	1.14												
.62-.64	1.14												
.64-.66	1.20												
.66-.68	1.32												
.68-.70	1.32												

Fig. 1 Form for recording volume of run-off from one or more plots or watersheds. This may be adjusted to include any convenient number of areas or any desired maximum gage height. The discharge rate is derived from the standard rating table for the flume used

Article prepared especially for AGRICULTURAL ENGINEERING. Author: Project supervisor, U. S. Soil Conservation Experiment Station, Raleigh, N. C.

Crop Rotation as a Factor in Soil Erosion Control

By John R. Carreker
MEMBER A.S.A.E.

THIS paper reports results showing reduced soil erosion and increased production of cotton when grown in rotation with close-growing legumes and small grains. For example, Bartel and Slater[1]* report results with cotton in tests at Statesville, N. C., showing that, over a 5-year period (1931-35), plots in continuous cotton lost 22.27 tons per acre of soil yearly, while those in cotton in a 4-year rotation of cotton, corn, fall wheat, lespedeza, and volunteer lespedeza, lost only 13.87 tons per acre, a reduction of 38 per cent.

However, such results are not limited to cotton alone. Borst and Woodburn[2] show that plots at Zanesville, Ohio, in corn continuously for three years (1935-37) lost nearly twice as much soil as corn during the same years in a four-year rotation of corn, wheat, meadow, meadow. Likewise Hays and Palmer[3] for tests at LaCrosse, Wis., report that for a three-year average, corn alone lost 89 tons per acre of soil per year, while corn in a three-year rotation of corn, barley, and clover-timothy lost 54 tons per acre. According to these investigators, "This reduction was caused by a combination of two factors: a more productive condition produced by the rotation and the presence during part of the growing season of decomposing tops and roots of clover and timothy plants."

Several rotations using cotton with soil-conserving and improving crops were started in 1939 and 1940 at the Southern Piedmont Experiment Station, at Watkinsville, Ga., on run-off plots equipped for soil and water loss measurements.

These rotations included (1) continuous cotton for checking purposes; (2) a 2-year rotation of cotton followed by oats and cowpeas for hay; (3) a 1-year rotation of cotton and crimson clover for green manure; (4) a 1-year rotation of cotton with crimson clover and ryegrass for contour balks, using balk patterns A and B[4]; and (5) a 3-year rotation of cotton, oats and lespedeza, and volunteer lespedeza. All plots were on a 7 per cent slope, 70 ft long, 1/30 acre in size, and on Cecil sandy clay loam soil.

Rotations 1 and 2 above were begun in 1939, and the others were started in 1940. Data collected to date are not conclusive, but may be considered indicative of the comparative value of these cropping practices.

TABLE 1. SOIL LOSSES AND CROP YIELDS FROM RUN-OFF PLOTS IN COTTON AFTER COTTON, AND COTTON AFTER OATS-COWPEAS

Rotation	Soil loss, Apr.-Sep. period, tons per acre			Seed cotton yield, lb per acre		
	1940	1941	2-yr ave.	1940	1941	2-yr ave.
Continuous cotton	9.56	15.63	12.60	572	468	520
Cotton after oats-cowpeas	9.61	13.07*	11.34	771	429*	600
Oats-cowpeas after cotton	6.25*	11.15*	8.70*			

*One plot only. All other data average of two plots.
NOTE: All plots on 7 per cent slope and 1/30 acre in size.

The soil losses from the plots in cotton, grown after oats and cowpea hay, showed a slight reduction as compared to soil losses from plots planted to cotton after cotton. Some improvement in yield was also indicated, as shown by the two-year data given in Table 1.

It is interesting to note that the soil loss during the oats-cowpea year of this 2-year rotation was almost as much as that from the cotton in the rotation. Soil losses were higher during winter on plots in oats sown between cotton rows, than they were on plots remaining in cowpea stubble, which represented the alternate year of this rotation practice. Also, during early summer, soil losses were almost as high on plots sown in June to broadcast cowpeas after the oat harvest, as on plots in cotton. When the cowpeas developed a good canopy in August, they provided better protection against both soil and water losses. This indicates a weakness in the oats-cowpea portion of this rotation, so far as erosion control is concerned. The oat stubble was plowed before cowpeas were sown, right at the critical time for soil losses from summer thunderstorms.

The amount of soil lost from continuous cotton plots during the April to September period amounted to about 95 per cent of the annual soil loss for the past two years of record. Hard thunderstorms in the summer have been much more erosive than slow winter rains. Bartel and Slater[1] report from Statesville, N. C., that this seasonal loss varied during 5 years from 53 to 98 per cent, or a 5-year average of 75 per cent, as compared to the annual losses.

The soil loss results for the 1941 spring and summer season for the rotations begun in 1940, together with the crop yields, are given in Table 2.

TABLE 2. SOIL LOSSES AND CROP YIELDS FROM RUN-OFF PLOTS IN COTTON IN VARIOUS ROTATIONS (1941)

Rotation	Soil loss, Apr-Sep period, tons per acre	Seed cotton yield, lb per acre
Cotton after crimson clover-green manure	19.46*	612*
Cotton after cotton	15.63*	468*
Cotton after oats-cowpea hay	13.07	429
Cotton after Kobe lespedeza	10.19	903
Cotton after cotton with Balk A	8.62	588
Cotton after cotton with Balk B	2.71	633

*Average of two plots. All other data from single plots.
NOTE: All plots on 7 per cent slope and 1/30 acre in size.

The highest soil losses recorded were from cotton after green manure, with the April-September 1941 seasonal record of 19.46 tons per acre. We are somewhat at a loss to account for this, and can say only that apparently the first-year crimson clover-green manure was turned under for cotton, and soil loss was not reduced thereby. The estimated green-weight tops yield of the green manure was approximately 3 tons per acre. Perhaps this was all decomposed by the time the erosive rains began the latter part of June. Bartel and Slater[1] reported a tendency for crop residues, both as green manures and dead material, to reduce soil losses from cotton and corn during a 5-year period.

The relatively low soil losses obtained from plots in cotton cultivated with the contour-balk system deserve attention. This practice consists of growing cotton after a crimson clover-ryegrass mixture, with the land prepared in the spring to leave an unplowed balk between the cotton rows. A detailed description of this practice may be found in the August 1939 issue of "Soil Conservation"[4]. Where the balks were left in each middle until early June, and the middles then plowed clean (balk A), the soil loss amounted to 8.62 tons per acre for the April-September

Paper presented February 4, 1942, at a meeting of the Southern Section of the American Society of Agricultural Engineers at Memphis, Tenn. Author: Associate agricultural engineer, Southern Piedmont Experiment Station, Soil Conservation Service, U. S. Department of Agriculture.

*Superscript figures refer to the bibliography appended to this paper.

period. Where balks were left only in alternate middles, but allowed to remain all year, the soil loss was reduced further to the low figure of 2.71 tons per acre. This is even a lower loss than that from the plot in oats and sown lespedeza, as given in Table 3, even though it is from a row crop with alternate middles cultivated clean and adjacent middles cultivated next to the row only.

TABLE 3. SOIL LOSS IN TONS PER ACRE AND RUN-OFF IN PER CENT OF RAINFALL, FROM ALL CROPS IN 3-YEAR ROTATION FOR APRIL-SEPTEMBER PERIOD (1941)

Crop	Rainfall, in	Per cent run-off	Soil losses, tons per acre
Cotton	19.97	20.2	10.19
Oats-lespedeza	19.97	37.2	4.61
Second-year lespedeza	19.97	6.2	0.12
Three-year average	19.97	21.2	4.97

The cotton yield with balk B is questionably high, because other tests at the station do not indicate any particular cotton productivity trend in this practice, as compared to green manuring. Likewise, the yield of the cotton after oats-cowpeas for 1941 is perhaps too low in view of the 1940 and 1940-41 average yield obtained, as compared to the continuous cotton yield shown in Table 2. The other yields may be considered fairly indicative of the treatments represented, on class III land of the Cecil series, as it occurs commonly on farms of the Southern Piedmont.

The reduction in soil loss from the plot in cotton grown after lespedeza, and the better yield of this cotton was quite striking when compared to the soil losses and the yield of cotton after cotton. An increase of almost 100 per cent in cotton yield meant money this year when boll weevil damage was quite severe. This yield of cotton after lespedeza was almost duplicated on a 17-acre field at the station under similar cropping practice.

The reduction in soil loss from 15.63 tons per acre for cotton after cotton to 10.19 tons per acre is considered significant. The cotton after cotton plot had 500 lb per acre of 6-8-6 fertilizer at planting time, whereas the cotton after lespedeza had 340 lb of 0-12-7 at planting and a side dressing of 200 lb of nitrate of soda per acre. With this exception, both plots received the same treatment throughout the erosive season of April to September. The hold-over effect of lespedeza apparently did something to the soil. Water losses were similar, but the soil was protected by the lespedeza debris to resist erosion. This cotton grown after lespedeza is part of a 3-year rotation of cotton, oats-lespedeza for seed, and lespedeza for hay. It is a rotation that has much merit for soil improvement as well as soil conservation. With it the land is exposed to serious washing only a portion of one year out of three, and apparently from the data shown the protection of the lespedeza holds over, to some extent, into the cotton year.

Table 3 gives the April to September period, 1941 soil and water losses from three plots in this 3-year rotation. The variation in soil losses from 0.12 ton per acre for the second-year lespedeza to 10.19 tons per acre for the cotton shows why this rotation has such a soil-conservation benefit. Considering also that the soil loss from this cotton was reduced approximately 35 per cent from that of continuous cotton, further emphasizes the conservation value of the rotation. Several large fields at the station, that have been in similar rotation practices for 3 or 4 years, have shown but little visible sign of erosion. Consequently, we are expecting still further reductions in soil losses after 2 or 3 years on these run-off plots.

Selected data for the 3-year cotton, oats-lespedeza, lespedeza rotation are shown graphically in Fig. 1. The relation of this rotation to continuous cotton in the erosion cycle is shown graphically in Fig. 2.

Assuming that these soil losses are representative of the comparative protective ability of these different crops to resist erosion during their respective years on the land, the average three-year summer loss then is arrived at by averaging the three together, for a value of 4.97 tons per acre. This value was approximately one-third that of continuous cotton losses, which, incidentally, is the portion of time cotton occupies the land in the rotation cycle.

The reduced soil losses on row crop land following lespedeza were borne out by observation in the 17-acre cotton field previously mentioned and in fields of corn, hegari, and sagrain. Yields of all these crops were high as compared to similar crops grown on other areas not improved by lespedeza, with the extent of increase being 75 to 100 per cent.

All these plot data quoted can be considered as indica-

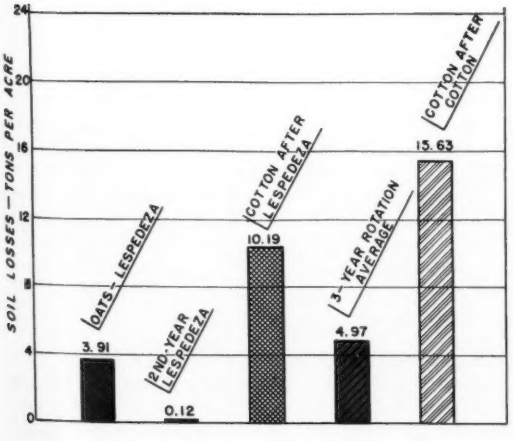
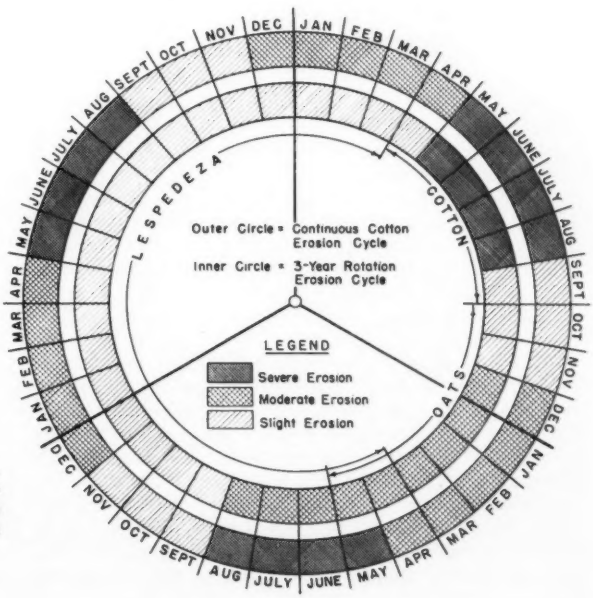


Fig. 1 (Above) Tons per acre of soil loss from cotton after cotton, compared with 3-year rotation, for April-September period, 1941, on 7 per cent slope run-off plots, 70 ft long and 1/30 acre in size • Fig. 2 (Right) Erosivity of 3-year rotation of cotton, oats-lespedeza, compared with continuous cotton erosion cycle



tive of trends only, because the plots in some cases are not replicated and but one to two season's results have been recorded to date. The 1941 season was the most erosive yet experienced at this station. The most severely erosive rain recorded in the four years' rainfall records at this station came July 11, 1941. It had an expectancy of once in 8 years according to Yarnell[5], on the basis of the hourly rate. During highly erosive rains like this, the plot inequalities tended to be smoothed out, and soil loss differences more nearly reflected the protective ability of a given cropping practice.

SUMMARY

Early crop rotation practices were designed strictly to maintain or improve crop yields. More recently emphasis has been put on reducing soil losses with cropping practices. That this can be done has been proven by work from 1930 to 1935 on several soil and water conservation experiment stations. It has been shown that soil loss from corn in a rotation with close-growing crops was less than from corn after corn, and similar results were obtained with cotton.

Recent work at the Southern Piedmont Conservation Experiment Station at Watkinsville, Ga., indicate that considerable reduction in soil loss and improvement in crop yields are obtained by rotating cotton with other crops. Of special merit are (1) the three-year rotation of cotton, oats-lespedeza, and lespedeza, and (2) the contour-balk system of cotton culture.

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A Short Method of Determining Volume of Run-off from Water-Stage Recorder Charts

(Continued from page 189)

form is 1.02 cfm, which is the difference in total discharge at those gage heights. Thus it is seen that the discharge rate for each increment of gage height merely is a component part of the total.

In addition to the form just described, it will be advisable to devise a scale, preferably of transparent material, graduated to conform to the minute lines of the chart (Fig. 2). The scale should be graduated from zero to possibly 360 min, or whatever duration is necessary to scale the average run-off period. The shape of such a scale will, of course, be determined by the shape and type of chart used.

Actual reading of the chart is effected by scaling off the average duration of each interval strip beginning with the bottom strip and recording it in the duration column. The zero point of the scale is placed on the rising side of the graph, and the time read in minutes on the falling side. The time is scaled along the center line of the strip since the average duration is wanted. After the time is scaled and recorded, each duration then is multiplied by the corresponding discharge rate, and the interval volumes summed up for the total volume. Thus the entire procedure is simply a matter of scaling the average horizontal interval duration, multiplying this by the corresponding discharge rate, and summing up the results for the total discharge.

Either of two methods of computation may be used. By one method, the computations for several plots or watersheds with identical rating curves may be carried through together, since all durations for a given head interval are to be multiplied by the same discharge rate. Each incremental discharge is recorded in its proper column, and these are summed up for the plot total. By the other method, the incremental discharges for a given area are carried along on the machine, and the total is given with the last computation. Either method is a simple matter on a calculating machine.

Discharge may be determined either in seconds or minutes. However, since duration is scaled in minutes, it will be found more convenient to compute discharge in cubic feet per minute. Conversion to seconds will be unnecessary and smaller figures will be used.

Ordinary care in determining head and duration with this short method should result in greater accuracy than with the standard method. The main reason for this is that any error in judgment as to duration affects only a low discharge rate, while error in duration with the other method may affect a high discharge rate. A second factor, though probably not so important as the first, is that by placing the zero point of the scale directly on one line of the graph, error in judgment practically is eliminated on that side. Thus on the other side the duration can be quickly read to the fraction of a minute, if necessary. Error in head determination is eliminated except at graph peaks, and here durations are very short. For fractional parts of head intervals the duration should be reduced in compensating proportion.

It is to be understood that only total volume of run-off can be determined by this short method. When hydrographs are to be prepared or rates of run-off or infiltration determined, the conventional method must be used.

Effects of Farm Mechanization

THE nature of competition is such that, in any widespread and highly competitive industry such as agriculture, those who would lead and thereby increase their incomes, must keep on improving their equipment and practices. It is true that any specific degree of mechanization influences other cost factors in a way which tends ultimately to neutralize the advantage of that mechanization. Furthermore, average farmers, and even the submarginal group, are continually improving their equipment and practices, so that the best and most profitable equipment and practices of leading farmers today may be only average some five or ten years hence, and still later may be submarginal or relatively backward. If a farmer advances his practices to a certain state of mechanization and efficiency, and stops his progress at that point, there is no doubt that adjustments in fixed costs and the progress of competing farmers will catch up with him.

Is it any point against farm mechanization that it has no fixed, ultimate ideal; that it must continually progress to maintain its advantage over competitors? Doesn't this mean that mechanization is an influence for general agricultural progress?

Mechanization is no complete or perfect means to material prosperity. It is misunderstood, misused, abused, and condemned for what it will not do. But it is an aid to progress, prosperity, and better living which farmers accept and demand.

Methods of Handling Hay

AS A FEATURE of the 1941 Fall Meeting of the American Society of Agricultural Engineers held at Chicago in December, the Committee on Hay Harvesting and Storage, a joint committee of the Power and Machinery and the Farm Structures Divisions of the Society, sponsored a symposium on the above-named subject. The formal papers dealt largely with the sweep or buck rake method of putting up hay. Starting with an introductory statement by Mr. Vutz, chairman of the Committee, the papers presented on this symposium follow.—EDITOR.

The Significance of Homemade Sweep Rakes

By Wilhelm Vutz
MEMBER A.S.A.E.

IT WOULD be too simple to assume that discussions of methods of handling hay can be confined to the use of the sweep rake, or the buck rake as most farmers like to call it. It looks as if during the next few years the whole problem of handling hay will be in a somewhat fluid state. The fact however that the recent eastern form of the buck rake does represent a solution by the farmers themselves, marks it for some special attention at this time.

When in this age of factory-made machines, we see farmers spend time and money to develop their own solutions to a pressing problem, it gives us considerable food for thought.

In an area extending roughly over 100,000 square miles, mostly in the states of Indiana, Ohio, and parts of Michigan and the fringes of the surrounding states, we have perhaps 5,000 homemade or blacksmith-made sweep rakes in service. The farmers using these rakes would not think of converting an old passenger car into a tractor or of building some other equipment themselves, if they can get a factory-made machine for the job. However, in the last few years they have built a considerable number of sweep rakes and mounted them on old automobile chassis, and a smaller number on various tractors.

Faced with a serious shortage of labor, many farmers have had to think of some equipment that would save work at haying time. They wanted something that fitted into the existing machinery set-up, and they wanted something else: Many of them are watching the newer and radically different methods of handling hay and the equipment needed for it; they want time and leisure to observe these new methods and to draw their conclusions. And the sweep rakes enable them to do that at a rather reasonable cash outlay.

Some of these men, pleased with their sweep rakes as they may be, will admit that this is by no means the ideal solution. There are, for instance, questions of cleanliness obtainable with baled hay and straw; or the question of the nutritional effect of a good deal of dust in the hay. Anyone who has watched a rear-mounted sweep travel at 20 mph through a dusty lane a third of a mile long will appreciate the large amount of dust that may be collected.

At this point, though, I want to forestall the facile assumption that these farmers are taking a backward step. Western sweep rake experiences can hardly be drawn upon to judge these eastern cousins. We are dealing here with a much more adaptable type of rake and with entirely different methods. We see sweeps used in connection with choppers and with balers; we see them carry loads of from 600 to 1200 lb into the barn, dropping them onto slings and pulling up these slings before going to the field again; and about the only thing we do not see is a stack in the open field.

More and more the whole question of hay handling equipment is bound up with the question of handling straw left in the field after combining. When we see these eastern sweep rakes do such diversified jobs as bringing loose or baled hay to the barn, straw to the baler, corn to the ensilage cutter or shredder, or shocks of grain to the thresher, we gain a fair idea of their versatility of use.

Author: Engineer, New Idea, Inc.

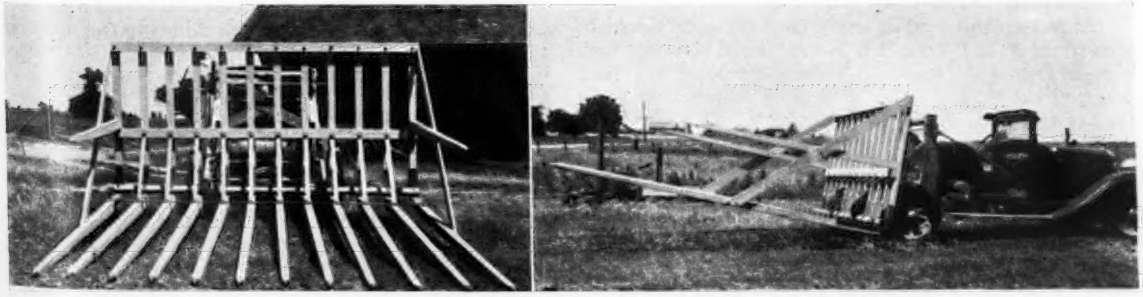
Sweep Rakes on Indiana Farms

By R. C. Shipman
MEMBER A.S.A.E.

IN THE past three years we have seen the number of sweep (or buck) rakes increase in Indiana from practically none to perhaps 1500 to 3000 at the present time. There were, of course, a few horse-powered and some tractor-powered rakes used by the larger farms where the hay is stacked in the field. However, this practice of storing hay is very limited in the state. The use of these earlier rakes did not spread to the majority of our farms because they did not fit their need.

The general farm which may have twenty acres of hay, is the one on which this relatively new sweep rake is being used. This acreage of hay most likely is alfalfa, and of course is cut twice, and in many cases three times. The hay is stored in the barn or feeding shed. It may be stored loose

Author: Extension agricultural engineer, Purdue University.



Two views of a typical homemade sweep rake, the teeth of which are 3x4s, 12 ft long

or by baling or chopping if space is at a premium. The hay has to be hauled from the field to the barn, nearly always having to pass through a gate or two and down the lane. These are livestock farms and are fenced with gates only 12 or 14 ft wide. The larger rake that is used to push hay around in the field will not go through these gates. Then there may be a highway to travel on to get from the field to the barn with a short grade to pull up from the field entrance. The farthest side of the field may be from 40 to 160 rods from the barn and oftentimes farther.

Now haymaking always seems to come at a time when there are a lot of other jobs to do, such as cultivating corn and hoeing soybeans. The weather man is not always agreeable and can slow things down pretty well, piling up farm work. Help is not the easiest thing to get for a short period time when everyone wants it at the same time. So the sweep rake provides one way of moving hay from the field to the barn with a minimum of labor. That is, one man can carry the hay to the barn as fast as two men can put it in the mow with the fork or slings that were used to unload it from the wagon.

In order to serve the farm conditions just mentioned, it seems that certain items in the construction of sweep rake equipment is desirable.

First, of course, it should be power driven as speed of travel is an important feature. It is necessary to have enough speed while loading from the windrow to build a sizable load. I have set 10 mph as the minimum loading speed. At this speed the load can be piled up against the backstop without much difficulty. The speed traveling to the barn with the load is important and I have set 20 mph as the top speed.

This item of speed has been one of the main reasons for mounting the rake on the rear of the old auto chassis. It will travel to the field as fast as the driver wants to go. He can load in reverse at 10 to 15 mph and then travel to the barn at a safe speed with a clear view of the road ahead. The load of hay is behind and will follow if he gets started through the gates right. This is one of the disadvantages of using the tractor — it is difficult to see the way ahead with a 6 to 7-ft pile of hay in front — thus it is necessary to travel slower.

ONE IMPORTANT ITEM IS THAT THE SWEEP RAKE SHALL HAVE AMPLE CARRYING CAPACITY

The second item of importance is that the rake should have ample carrying capacity, and of course this is more important as the distance of haul increases. It should have a capacity of from one-third to one-half of the load hauled on the 12 or 14-ft hay rack, that is, from 800 to 1200 lb. Hauling the same distances the operator of the sweep rake can make three to four trips to one load with the wagon and thus move about twice as much hay to the barn in the same time at a cost in ratio of about 3 to 5 in favor of the sweep rake compared to the wagon and loader.

As to the third item of importance, the rake should be constructed so that when it is loaded, it can be raised high enough from the ground to prevent the loose hay from dragging the ground. This serves two purposes: It keeps the hay free from dust or contamination, and it also holds the hay on the rake. With the ends of the teeth 3 to 5 ft from the ground, the effect of a large basket is obtained. This extra height also helps when traveling over uneven ground or pulling out on the lane or road which has a grade above the field level.

This extra height of lift brings up a fourth item; that is, it is desirable to have a power lift. The power lift is favored by many farmers, yet a large number of the rakes are used with hand windlasses because of the difficulty in constructing a power lift. The lifting device is one thing that the builder of the rake takes great pride in showing. There are many types too numerous to describe. The most common, however, is that of using an old auto rear axle with power from the fan pulley of the motor. The lifting device seems to be the big problem in constructing the rake, and I question the safety of many in use.

The last item I wish to mention in regard to construction is the size of the rake. In order to pass through farm gates, ten feet seems to be the desirable width of rake. With this width it is necessary to have at least ten or better yet 12 ft length for the teeth with a back stop about 5 ft high. This extra length on the teeth calls for stronger teeth to carry the 800 to 1200-lb load. We see all sizes and shapes of teeth on the rakes from 2x4's laid flat to 2x8's set on edge. It seems that a 3x4 gives the most desirable tooth because it has strength to hold the load and does not whip sideways. The spacing of the teeth is a factor that receives much discussion. These rakes are not only used for dry hay, but in some cases are used for green hay, corn, and sorghum to the silo, and, of course, straw and even bales of hay. For the green hay and straw a close spacing of 8 in between edges of the teeth is desired to give extra strength and prevent loss of hay between teeth when loading.

There are several reasons why many of these sweep rakes have been homemade. An important item certainly is cost. The average homemade rake is assembled at a cost of not over $100. This allows $50 to $60 for materials for the rake and $50 for an old auto chassis. Many are purchased for less. The equipment can be constructed so that it will work under the conditions that exist on the farm. In the past this type of equipment suitable to general farm conditions has not been available. Although many of the rakes are built by blacksmiths or local shops, it is a type of construction that can be handled by the mechanically minded farmer.

Although the sweep rake has helped to answer the hay and roughage handling problem on many farms, we cannot expect it to be adopted by every farm. The sweep rake is just one of the developments in equipment to do one of the hard jobs on the farm. The pickup baler and field roughage cutter have probably been responsible for the increased interest in hay lifting equipment. Certainly we should give the farmer due credit in doing something about his roughage handling problem.

Baling Method of Haymaking

By L. G. Samsel
ASSOCIATE MEMBER A.S.A.E.

THE COST of haying methods employing the use of the windrow pickup baler can not justifiably be compared with other methods of handling a hay crop, unless they also include baling. To put the hay in marketable condition and adapt it to long-distance transportation requires that it be baled.

Cost comparison of different methods are incomplete — in fact they are likely to be misleading — unless consideration is also given to the resulting quality and market value of the product.

The baling method of hay harvesting consists of three phases, each designed to preserve the maximum feeding value of the standing crop:

1 *Cutting.* The first step in our system is timely

Author: Advertising department, J. I. Case Co.

cutting — a period when the protein content is high and the crop sufficiently mature to avoid appreciable loss in tonnage. For alfalfa this is about one-third in bloom. The area to be cut should be limited to the amount that can be cured sufficiently to be raked the same day.

2 *Windrowing.* The next step is windrow curing. A left-hand side rake is used, starting at the same point as mowing and following the path of the mower around the field. A left-hand rake is important because it places the windrow on previously raked stubble (all the hay is raked), and following the direction of the mower, it rakes against the tops of the plants tending to invert the swath position of the hay. This exposes the stems to faster curing action of wind and sun, retards leaf curing, reduces bleaching, and helps to cure the hay more uniformly.

Raking starts while the leaves in the first swath of hay are still soft. To assure uniformity of curing and quality in high-yielding hay, only one mower swath is raked, and the rake travels at the same speed as the mower. The resulting windrow should be light and fluffy to permit free circulation of air.

3 *Baling.* Baling starts at the same point in the field as mowing and raking, and follows the same path and at the same speed. Baling starts when the hay cut and raked first would be considered safe for loose storage. Alfalfa containing 24 per cent moisture will keep sweet in the new sliced type bale if placed in well-ventilated storage.

Auxiliary Equipment. The new light-weight baler is no load for the average tractor, and a trailer cart or wagon to carry the bales can be readily pulled behind. An extension to the baling chute delivers the bales to the trailer. Some growers use a homebuilt dump trailer. Others use the standard low wheel wagon with a flat bed and stub pole, a loaded wagon being hauled to the barn or hay shed while another is being loaded.

One large operator in Indiana has devised a portable elevator for carrying the bales to barn lofts. Possibly with some changes in design, the present portable ear corn elevator could be used for this purpose.

Because baled hay is compact and resists the entrance of moisture, it does not require expensive storage facilities. Many producers stack the bales in the field. The stack tops are covered with tarpaulin or waterproof paper. The conventional hay shed with open sides and adjacent to the barns offers ample protection from the elements.

This Case tractor and pickup baler gather and bale hay in one continuous operation

The Chopping and Storing of Hay

By F. W. Duffee
MEMBER A.S.A.E.

THE RESULTS of several years of research work at the Wisconsin Agricultural Experiment Station on the storing of hay that is chopped either in the field with the forage harvester or with an ensilage cutter at the barn just as it is being hauled in from the field, may be summarized as follows:

1 The hay should be just a little drier for storing as chopped hay than as whole hay. Specifically, it should be dried to a moisture content of about 25 per cent in order to avoid discoloration in storage. The results of work at other stations indicate that whole hay can be stored with a moisture content of about 28 per cent. As no equipment is at present available for quick determination of moisture content, the following method will be of assistance in determining correct moisture content for anyone who is at present familiar with the curing and making of hay. If the hay were dry enough so that it would keep satisfactorily when stored in large quantities, then it is dry enough to store properly in the chopped condition. If, on the other hand, there was doubt as to whether or not the hay was quite dry enough to *store safely* and *in large quantities,* then it is a little too damp to chop into the mow.

2 The cutter should be set for a 1¾ to a 2-in cut. When set for this cut, the actual length of cut of much of the material will be considerably more than this amount, with some of it cut to lengths of 4 to 6 in long. The use of a shorter cut will make the hay much more dusty and will also require that it be drier before storing in order to avoid discoloration and excessive heating.

This length of cut can usually be obtained by securing special gears and using two knives.

3 Studies here and at the Michigan station, together with experience gathered from the field, indicate that the danger of spontaneous ignition in chopped hay is somewhat greater than with whole hay, if the hay is stored in too damp a condition. Studies at the Wisconsin station indicate that storing chopped hay in ventilated bents about 8 ft wide will greatly reduce, if not entirely eliminate this danger. These narrow bents apparently permit the dissipation of heat sufficiently to avoid overheating and spontaneous ignition.

Satisfactory construction would consist of dividing the hay mow into bents about 8 ft wide, using partitions made of vertical 2x4-in studdings on both sides of which are nailed 1x2-in slats spaced 2 in apart with the top and bottom of the wall so constructed that air may move freely up through the ventilated walls. Such construction should not be considered a hay drier, because hay stored in this way must be dried down to about 25 per cent moisture if discoloration is to be avoided.

4 Experience in feeding trials indicates that under ordinary conditions, chopped hay using the long cut as suggested above, will be consumed as readily as whole hay. In the case of feeding out of self-feeders and perhaps in some other cases, there will be less wastage of chopped coarse hay than when feeding it whole.

5 Chopped hay will require less storage space than whole hay, and when using the length of cut of 1¾ to

Paper presented December 3, 1941, at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill. A contribution of the Power and Machinery Division. Author: Professor of agricultural engineering, University of Wisconsin.

2 in, the storage space will be reduced about 40 per cent as compared to storing it whole or unchopped.

6 The recently developed forage harvesters for grass silage may also be used to advantage in putting up dry chopped hay, also for gathering straw after combining. In many cases, one man driving the tractor, pulling the forage harvester, picks up, chops, and loads hay without additional help, although it may be necessary to stop once or twice to spread the chopped hay in the wagon box.

The Automotive Buck Rake in Ohio

By C. B. Richey and R. D. Barden
MEMBER A.S.A.E. MEMBER A.S.A.E.

IN 1935 the first automobile buck rake (also called "sweep rake") in Ohio was constructed by Bill Baxter of Van Wert. Since then the use of these tools has spread up and down western and well into central Ohio. Furthermore, this spread has come about through first-hand information passed from farmer to farmer with practically no advertising or other publicity.

Some of the reasons for this increase in the use of buck rakes are revealed by the figures in the accompanying table taken from Bulletin No. 146 (mimeographed), entitled "A Study of the Newer Hay-Harvesting Methods on Ohio Farms," based on a study carried out by F. L. Morison as a project of the Ohio Agricultural Experiment Station.

HANDLING AND STORING DRY HAY — WINDROW TO MOW

Method	No. of farms	Tons of hay handled per farm, average	No. of men in crew, average	Tons per hour by crew, average	Man-hours per ton, average	Total cost per ton, average
Wagon and loader	28	30	3.4	1.1	3.1	$1.76
Auto buck rake	84	41	3.1	1.8	1.7	1.03
Tractor buck rake	53	35	2.6	1.3	2.0	1.37
Pickup baler	23	41	3.2	1.2	2.7	2.60
Stationary chopper, wagon, and loader	4	60	5.4	1.5	3.6	2.97
Stationary chopper and buck rake	6	57	2.3	1.7	1.4	1.96
Large field chopper	3	86	3.6	2.9	1.2	1.96

In calculating costs, the following rates were charged: Man labor, 25c per hr; horse labor, 15c per hr; tractor, 45c per hr; auto, 35c per hr; buck rake attachment, 40c per hr; wagon, 10c per acre; slings or forks, 3c per acre; hay loader, 38c per acre; pickup baler, $1.20 per ton; stationary chopper, $1.50 per hour; field chopper and blower, $1.20 per ton.

In addition to handling dry hay, buck rakes have proved to be efficient at several other jobs including bringing green hay to the silo, grain shocks to the thresher; combined straw to the baler, stack, or barn, and corn shocks to the husker-shredder.

The agricultural engineering department of Ohio State University was besieged by requests for information and plans last winter and spring so this past summer (1941), as a project of the Ohio Agricultural Experiment Station, many of these locally constructed buck rakes were studied in the field in order to discover designs which met the requirements and were also practical for local construction. A bulletin, entitled "Automotive Buck Rakes," has just been released and contains plans for automobile and tractor rakes.

Authors: Respectively, assistant professor of agricultural engineering and extension agricultural engineer, Ohio State University.

The requirements for rakes to be used for bringing hay to the barn differ somewhat from those for western rakes which bring hay to stacks in the field. Some of the more important requirements for corn belt conditions are as follows:

1 Capacity of 700 to 1000 lb per load, especially important if the length of haul exceeds ⅛ mile one way.

2 Speed of at least 8 mph, also especially important on the longer hauls.

3 Width which gives adequate clearance for ordinary gates and lanes. A 10-ft width with 12-ft teeth is a combination very popular with Ohio farmers.

4 A lift of 4 ft or more at the ends of the teeth. This prevents the hay from dragging and stirring up dust and also from shaking off while being hauled.

5 A power lift, since a lot of "elbow grease" is required to lift a 1000-lb load two feet off the ground by hand.

Mr. Morison's data indicates that automobile rakes were more efficient than tractor rakes. This was probably due to the fact that many of the tractor rakes were mounted on old model, slow-speed tractors, and also most of the tractor rakes were commercial models which did not have enough capacity to be efficient on long hauls. Where the rake is carried by the tractor, large loads can easily damage the front tires and wheel bearings, so in order to secure adequate capacity the rake should be carried on wheels of its own. One way of doing this, devised by Alfred Brubaker, is to mount the rake on a widened automobile front axle, pushed ahead of the tractor and steering with it.

If large loads are to be lifted well off the ground, the regular tractor implement lift is inadequate and some other source of power must be used. The tractor power take-off would seem well adapted for this, and it has been successfully used to drive an automobile rear axle having a cable winding drum on one hub. When the hub opposite the winding drum is braked, differential action causes the winding drum to turn, and then the load can be kept lifted by braking the drum side of the axle. This system was devised by Philip and Herman Hilty for use on auto buck rakes, the rear axle being driven from the fan belt through a transmission in low gear. For a commercial tractor rake, the power take-off could operate a winding drum by means of a worm gear and no brake would be needed to keep the load lifted. A tight-and-loose V-belt drive with a friction reverse might prove practical.

AUTHORS SEE POSSIBILITIES OF HIGH-SPEED TRACTOR AS MOUNTING FOR BUCK RAKE

There is no reason why a tractor buck rake of adequate capacity, and mounted on a high-speed, rubber-tired tractor, should not be nearly as efficient as the best auto buck rakes. Most farmers would prefer a tractor rake meeting the requirements to an auto outfit because of the lower investment and upkeep.

When automobiles or trucks are used, it is generally agreed that it is best to have the rake mounted on the rear end. This necessitates removing that part of the body which is behind the front seat. The disadvantage of having to load in reverse is outweighed by the following advantages over the front mounting: (1) No loss of traction when the load is lifted; (2) more cooling air for the radiator; (3) easier to maneuver through gates, lanes, and

around corners; (4) less side motion of the teeth when loading, thus reducing breakage, and (5) better driving vision when going to the barn.

The ideal buck rake automobile is one which is sturdily built and in good condition but out-of-date enough that it can be purchased for a reasonable figure. Buicks and Model "A" Fords are very popular along with various makes of old trucks. Since the car can give much more trouble than the buck rake, the prospective user should pay enough to get a sound car.

The first buck rakes in a community are usually built by the farmers themselves, but later the local welding shop gets into the business. Last winter and spring there were several welding shops in northwestern Ohio which built 25 or 30 rakes complete with power lifts and attached them to farmers' cars at prices ranging from $95 to $125 per job.

The buck rake is a relatively new tool in Ohio and farmers have had to learn how to use it most effectively. It is interesting to observe the standard practices which have developed in communities with several years of experience.

In the operation of this tool, some farmers take the hay from the swath, but most of them use a side-delivery rake and make a double windrow for faster loading. In the case of long hauls, it is usually desirable to "double-load". This refers to raising a second load as high as possible with the power lift, dropping it on the first load, and then taking both in at once.

A few farmers make a practice of bunching the day's hay with the buck rake just as soon as it is dry enough, and hauling the bunches to the barn later. They state that this results in higher quality hay because none of it gets too dry or is exposed to any more sunshine than necessary.

At the barn, slings are universally favored for getting the hay into the mow. The slings are spread out on the ground, the load of hay dropped on them, and the rake pulled out. Some loose hay placed under the slings where the back of the rake comes down will help keep part of the load from staying on the rake. Slings which will handle a rake load at a time are preferred.

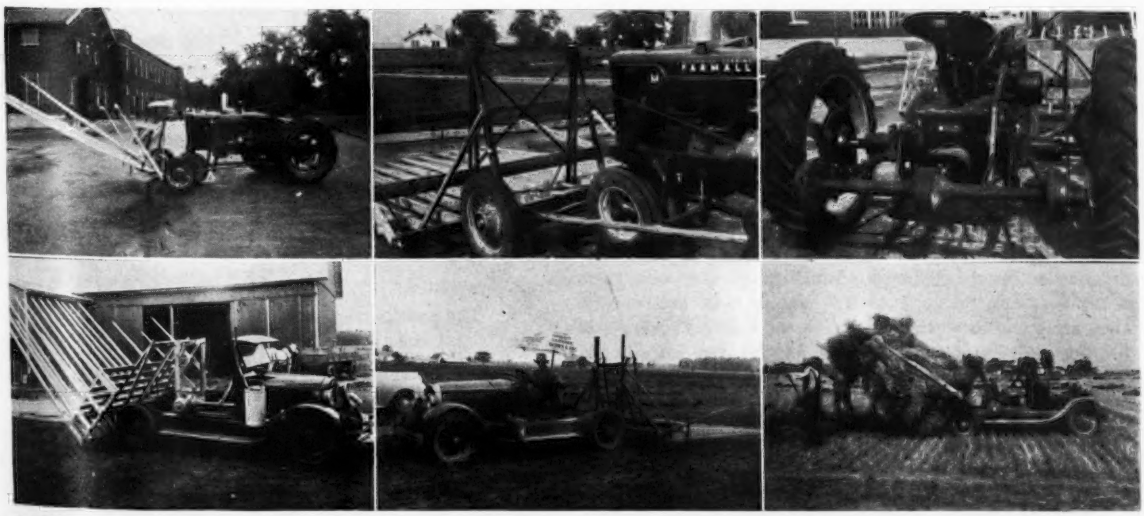
Farmers state that hay gathered with a buck rake and taken into the mow with slings loses very few leaves and also mows away much easier than hay forked from a wagon because it is not matted together but can be easily torn apart. If the barn will not accommodate slings, a four-prong loose grapple fork is next best. Bucked hay is usually too loose to fork efficiently.

With a buck rake, one man can put up hay with slightly greater efficiency, in terms of man-hours per ton, than a crew of two or three men. Many farmers are doing this, the general procedure being to haul in and pull up two or three loads, and then go up and mow them away. They usually arrange to pull the hay rope with the rake as they leave the barn.

Green hay for grass silage does not load as nicely as dry hay, but because of its weight it does not take as much to make a load. Large windrows made by a side-delivery rake load the best. At the silo this windrow will feed into the cutter like a rope if one end is started. Two men feeding this "rope" with their bare hands can easily keep the cutter working at capacity. One buck rake will keep a cutter busy if the haul is short.

When hauling grain bundles to a thresher, it is often desirable to keep a man or two in the field to collect and throw on missed and dropped bundles. It is the general opinion among users that not much grain is shattered if bundles are not allowed to drag. In case of unloading difficulties, a rope placed across the back of the rake before loading and held at each end while the rake is pulled out will do the job. An extension feeder on the threshing machine helps reduce the labor of pitching in the bundles. Buck rakes make it possible to greatly reduce the size of the threshing crew, since each one displaces four or five wagons. This is especially appreciated where the old threshing rings are breaking up because of increased use of combines. Some custom threshermen are offering to haul in the bundles with buck rakes as part of their regular service.

Buck rakes are quite popular for bringing in the straw left by combines. The straw may or may not be windrowed



(Top) Three views of a tractor buck rake constructed by the agricultural engineering department of the Ohio State University. Right-hand view shows power-lift device. (Bottom) Three homemade auto buck rakes built by Ohio farmers

first. Bringing the straw to a stationary baler involves few problems. Stacking it in the barnyard is more difficult and no simple solution has been found. A few farmers have rigged up high capacity blowers from parts of old threshers. Some are running the straw through an ensilage cutter and blowing it into the barn. Feeding is slow but storage space is conserved and the cut straw is more efficient for bedding purposes than long straw since it is more absorbent.

A few farmers are using buck rakes to bring corn shocks to the husker-shredder. Those who do are enthusiastic about the labor saved. Under adverse field conditions, tractor rakes have the advantage of better traction than auto or truck rakes. From one to four shocks can be hauled at once, depending upon their size. The rake is lifted between shocks in order to prevent tooth breakage and to pull up "gallus" hills or frozen-down butts. The shocks are harder to get off the rake than hay if the teeth are placed flatwise, and in this case it may be desirable to have some sort of a stop, such as a heavy plank, which will catch the butts of the stalks after the rake has been lowered and hold them while the rake is pulled out. Since husker-shredders are not designed for feeding from the ground, a problem is encountered here. One solution is to use an auxiliary platform halfway up and have one man throw the bundles on this while another lifts them to the upper platform.

Many miscellaneous uses for buck rakes have been reported such as hauling baled hay, sacked grain, orchard brush piles, and farm machinery. Owners seem to feel, almost without exception, that the buck rake has a permanent place on their farms and, as far as they are concerned, the forage harvest has been mechanized.

Factory-Made and Homemade Sweep Rakes Compared

By F. D. Jones
MEMBER A.S.A.E.

IN OUR trips to areas where they are used, we have found that sweep rakes meet the requirements for certain conditions. These include very rough, swampy, boggy ground, very roughly corrugated, irrigated ground, places where the sweep must travel considerable distances with its load, and places where special sized heads are required to work with special types of stackers used there. These are conditions in which the homemade sweeps have a well-established place, since an implement manufacturer could not afford to do the necessary development work and equip his plant to produce the limited number of machines required for these restricted territories.

Factory-made machines are necessarily built for generally similar operating conditions which are the most commonly found in the large sweep rake areas of the country. They are made to work with the factory-made stackers sold through the country. As manufacturers, we consider a sweep rake to be an implement for moving large quantities of hay comparatively short distances quickly, and our machines are built with this in mind. Being a machine which is used only a short period of time each year, we try to keep the price down to a minimum.

In designing factory-made sweep rakes we try to keep

Author: Engineer, Dain Mfg. Co.

A John Deere tractor and hay sweep in action

in mind the tractors on which the rakes will be used. This involves the use of the attaching bolts, brackets, or pads provided for mounting the equipment on the tractor, and making it unnecessary for the user to remove important supporting parts of the tractor in order to mount the sweep on it. We try not to interfere with the proper cooling of the tractor engine, to put more weight on it than it should carry, or to do anything which would make it unstable or hard to maneuver or operate. Proper consideration is given to the safety of the operator in the use of the equipment. We have seen homemade machines in which the builder had either overlooked or ignored the importance of one or more of these features in the construction of his implement, and damage to the tractor has resulted in its use.

One important essential is that the sweep be quickly and conveniently attached to and removed from the tractor. An operator may be using the same tractor for mowing, cultivating, and sweeping, and changes from one implement to the other must be made quickly.

Repairs for factory-made machines are generally available at the dealer's store and are reasonably priced, making it unnecessary for the farmers to have a piece made up by a blacksmith or welder before he can get back to work after breaking a part. This saves time and money as well.

There are several sweep rakes on the market which can be changed from one tractor to another by the purchase of a few attaching parts. This makes it unnecessary for a user to get a whole new machine if he changes tractors.

As to costs, we find in all the information available on the cost of operating farm equipment, that the time the equipment is used is one of the most important factors influencing its cost of operation. In the case of power sweep rakes, we believe the operating costs can be kept to a minimum by using them with general-purpose tractors, as the tractor is used a large number of hours, and as the source of power, it is the most expensive part of the equipment. The sweep rake is used only a comparatively short time, but as it is a low cost machine, the fixed costs such as interest and depreciation are low.

In concluding, I wish to say again that I believe there is an important place for both homemade and factory-built sweep rakes. Some of our most popular farm equipment has started out as a machine built by a mechanically inclined farmer or country blacksmith, and we believe they are still making their contributions to the improvement of the farmer's implements.

The 1942 A.S.A.E. Gold Medalists

D. P. DAVIES

The American Society of Agricultural Engineers announces the selection of D. P. Davies as the recipient of the John Deere Medal and W. D. James as the recipient of the Cyrus Hall McCormick Medal for 1942. Formal award of the medals to Mr. Davies and Mr. James will be made at the Society's annual dinner at Milwaukee, July 1st.

W. D. JAMES

IN March of 1873 a Welsh immigrant family settled on a farm near Racine, Wisconsin, with a son in his third year. When this child was sixteen he got a job as a machinist apprentice in the shops of the J. I. Case Company. Today that farm is the site of the company's great tractor works, and the boy, D. P. Davies, is vice-president and consulting engineer for all the plants of that same company. His achievements in the intervening years have won for him the John Deere Gold Medal for 1942.

Born August 1, 1870, at Towyn, North Wales, David Pryce Davies got his formal education in country and city schools, at night school during his apprenticeship, and later as a special student at the University of Wisconsin. Another notable part of his education was a sojourn of some two and one-half years in Germany as engineering representative for the Allis-Chalmers Mfg. Company, studying design and operation of double-acting blast furnace gas engines which the company was building under license by the M.A.N. Company of Nuremberg. While abroad he also studied high-head hydraulic turbines as built by Esher-Weiss at Zurich, Switzerland, and steam turbines built by the Parson concern and by Willans & Robinson of Rugby, England. After return to America he supervisel the installation of large blast furnace engines at the Homestead works at Pittsburgh, at the Illinois Steel Company in Chicago, and in the new Gary plant.

All this was ad interim. His first and last devotion has been to power for the farm. In 1892 he assisted in the design and made all drawings for the gas tractor built that year in the Case shops, believed to be the first such tractor to travel on its own power and perform farm work. In 1896 he designed the side-crank steam traction engine of which the Case Company built many thousands through a period of years. Following his European experience, his work with steel mill engines, and two short engagements, he returned to Case in 1910 and from that time forth his record is written in the history of that company's contributions to farm power.

D. P. Davies is a member of the Society of Automotive Engineers, a director of the Milwaukee post of the Army Ordnance Association, and holder of a Modern Pioneer Award. He is a member of the Masonic order, Wisconsin Consistory, and Tripoli Temple Shrine of Milwaukee. He and his wife, nee Mattie Jones, have a son David Pryce, Jr. and a daughter Beth.

TRADITION tells that W. D. James came from his father's farm and entered the manufacturing business with $2.50, a few ideas, and a lot of ambition. Today that well-balanced capital has grown to include factories in three states, annual sales volume measured in millions of dollars, and an engineering staff of 175 men, all of which constitute the James Mfg. Co., of which he is president. Not for the magnitude of his business, but for well-nigh countless contributions to the design and equipment of farm structures, he has been chosen to receive the 1942 award of the Cyrus Hall McCormick Gold Medal.

William David James was born May 21, 1881, at Milwaukee, Wisconsin, to David D. and Maria (Hughes) James. During his early life on the family farm at Wales, Wisconsin, he attended country school and St. John's Military Academy at Delafield. Later he completed business courses with the International Correspondence School and LaSalle Extension University.

His career began with consideration for the comfort of a cow, and his first design of a swiveled stanchion to replace the conventional, rigidly parallel pair of scantlings. Then came steel stall partitions to keep cows from encroaching on each other's comfort, and a seemingly endless succession of watering bowls and systems, ventilating devices and systems, designs for gutters, mangers, and complete barns.

Although dairy structures and equipment have been bellwethers in the James parade, housing of other livestock has long since been included. Poultry has become a specialty with equipment for incubation and brooding, as well as general feeding and housing devices and designs. Crop storage also has claimed its share of the James genius with the development of the "hay keeper" and other fireproof, scientifically ventilated storage structures.

Among his many memberships are organizations devoted to dairying, poultry, fire prevention, conservation, sports. He is a 33d degree Mason and active official member of the Congregational Church. Mr. and Mrs. James, nee Florence Westcott, live in a modest home facing the Fort Atkinson factory.

NEWS

Extension Program to Feature Wartime Problems

THE Committee on Extension of the American Society of Agricultural Engineers announces, through its chairman, C. N. Hinkle, that a program of outstanding interest and value is being planned for the extension group session at the Society's annual meeting at Milwaukee this month. The session will be held at the Schroeder Hotel, Milwaukee, on Monday evening, June 29.

The object of the session, as outlined by Mr. Hinkle, will be to discuss some of the extension problems resulting from the present war emergency, methods being used to meet these problems with results being obtained, plans for the coming year, and the feasibility of extension agricultural engineers both in the states and in private industry cooperating more closely in promoting and making available extension material of general interest.

The session will be opened with a few brief reports which will be followed by general discussion. Extension agricultural engineers in both public and private employ are urged to come to the meeting prepared to present any pet ideas which they feel would be helpful to the group in general to do a more effective job of meeting the war emergency in 1943.

Case Invites Ag Engineers

AS A part of its centennial jubilee celebration the J. I. Case Company is arranging a special demonstration for members and friends of the American Society of Agricultural Engineers to be held July 2nd at Racine, Wisconsin, at the close of the Society's annual meeting at Milwaukee.

This post-meeting feature will consist of an interesting historical demonstration of 100 years of progress in farm power and 100 years of development in the threshing of grain. It will be held at the Old Settlers' Park, Union Grove, 16 miles west of Racine and almost due south of Milwaukee. Proper and necessary transportation, where needed, will be arranged for by the Case Company. Luncheon will be served at the park.

Starting at 10 o'clock in the morning, the demonstration showing the progress and development in the art of threshing will include the crude and primitive operations of flailing and perhaps winnowing. This will be followed by actual threshing of grain with a groundhog thresher as built about a century ago, an apron thresher manufactured in the sixties, an agitator thresher as used in the eighties, and an early model steel thresher first produced by the Case Company in 1904. Because grain will not be ready to harvest at Racine at that time, it will be impossible to show the latest development in grain handling machines — the combine — at work in the field. The combine, however, will be on display to complete the progress picture.

The power demonstration will include men working with the old-time threshing flails, horses on a tread power, the 12-hp Case steam engine No. 1 built in 1869, an early portable steam engine, a 65-hp steam engine, a 20-40-hp gas tractor of 1912, a Model "L" tractor made in 1929, and a Model "SC" of this year's production.

Some of the machines are museum pieces. Case steam engine No. 1 has been on display at the Ford Agricultural Museum at Dearborn, Michigan, for a long time and was also exhibited at the World's Fair at Chicago in 1934 by Ford. Other pieces of equipment came from attics of old families and others from the Museum of Science and Industry in Chicago.

The Case Company cordially invites the members of the Society to be their guests on July 2nd for this affair. Further details as to methods of transportation, etc., will be announced at the time of the Society's meeting in Milwaukee.

McKibben to Michigan

MICHIGAN State College announces the appointment of Dr. Eugene G. McKibben as the new head of the agricultural engineering department of that institution, effective August 1. He succeeds H. H. Musselman, whose retirement is announced by the College after having served the agricultural engineering department of that institution for thirty-three years, most of the time as head of the department.

Dr. McKibben, a native of Arkansas, was graduated from the professional agricultural engineering course at Iowa State College in 1922, and following graduation he accepted a position on the agricultural engineering staff of the University of California, and in 1927 received his master's degree in agricultural engineering from that institution. In 1928 he joined the agricultural engineering staff at Iowa State College, with which he has since been connected, as associate professor and more recently as professor of agricultural engineering. While on leave from Iowa State College, from September 1936 to August 1937, he was engaged as agricultural engineer on the National Research Project sponsored by the Works Progress Administration, in which he made a study of the effects of changing agricultural engineering techniques on employment in agriculture. In 1936 he was awarded the Ph.D. degree in agricultural engineering by Iowa State College.

A.S.A.E. Meetings Calendar

June 29 - July 1—Annual Meeting, Hotel Schroeder, Milwaukee.

November 30 - December 2—Fall Meeting, Stevens Hotel, Chicago

J. Q. McDonald Promoted

ANNOUNCEMENT is made by the Caterpillar Tractor Company of the promotion of John Q. McDonald to the position of general sales manager.

In 1927 Mr. McDonald joined the company as supervisor of agricultural sales for the western United States and western Canada, and in 1929 he went to Europe to study the application of track type tractors to Russian conditions. In 1930 he returned to this country and served four years as district representative for the company in various parts of the country, becoming district representative at London and countries of northern Europe in 1934. In 1936 he returned to this country to serve as export sales supervisor and assistant export sales manager. He has held the position of export sales manager for Caterpillar since 1940.

Southwest Section Meeting

THE Southwest Section of the American Society of Agricultural Engineers, the territory which is comprised of the states of Arkansas, Louisiana, Oklahoma, and Texas, held a very successful meeting at the New Caddo Hotel, Shreveport, Louisiana, on April 3 and 4. Not only was the meeting well attended by agricultural engineers from the states comprising the Section, but several members of the Society from outside the area were also in attendance.

New officers of the Section elected for the ensuing year are: *Chairman,* Howard Matson, chief, engineering division (Region 4), U. S. Soil Conservation Service; *(Continued on page 202)*

A.S.A.E. President-elect H. B. Walker in huddle with associates and Central California Beet Growers Assn. officials on plans for an intense mechanization drive among beet growers for adoption of cross cultivation of beets instead of thinning by short-handled hoes. Left to right: Gordon Lyons, secretary, C.C.B.G.A.; S. W. McBirney, associate agricultural engineer, U. S. Department of Agriculture; Professor Walker, head of the division of agricultural engineering, and Roy Bainer, associate professor of agricultural engineering, University of California; and Robert Barr, president, C.C.B.G.A. (Photo by courtesy of F. Hal Higgins)

How to make $1000 buy more building for the farm . . . .

AMERICA is accustomed to getting results with the materials and tools at hand. It is adaptable, flexible, ingenious. Right now there is a limitation on farm construction. Only so many dollars can be spent per year—and that includes materials and labor.

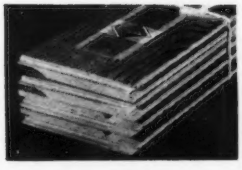
Today, as never before, the need is to get more for the building dollar—to save materials—to save man hours in erection—to get better building, whether new construction or repair and remodeling.

4-Square, ready-to-use lumber enables every designer to do more—every farmer to get more, because this improved lumber speeds construction, reduces material waste, assures good workmanship.

4-Square Lumber is precision manufactured at the mill. It comes in accurate lengths and sizes, for all standard construction purposes, with ends and surfaces already squared. Its use eliminates needless sawing, fitting and material waste, thus saving building time and lowering building costs. Furthermore 4-Square Lumber also assures tight joints and full bearing of all load bearing members, which are important features of good construction.

Designers using 4-Square Lumber, in its great variety of sizes, lengths, species and grades effect great economies in farm building. Complete catalogs of 4-Square Lumber and lumber specialties are available on request.

4-SQUARE ENDLESS DROP SIDING



4-Square Endless Drop Siding is tongued and grooved on ends as well as edges. This permits interlocking of each piece with adjoining pieces, providing a tight, rigid wall surface. Pieces need not be joined over the framing members as is required when plain, or square-end lumber is used. Cutting and fitting are unnecessary except at openings and at corners. 4-Square Endless Drop Siding is produced in all standard 6-inch patterns in two grades each of Douglas Fir and West Coast Hemlock.

4-SQUARE LUMBER

WEYERHAEUSER SALES COMPANY • ST. PAUL, MINN.

WEYERHAEUSER 4-SQUARE LUMBER

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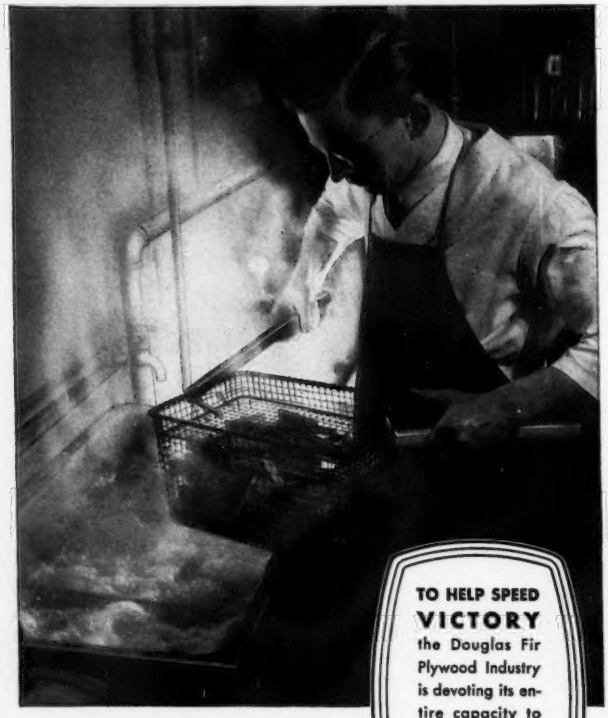
● The answer is *long enough to prove that continued boiling would still have no effect on the phenolic-resin bond between the plies.* You see, boiling is just one of a series of tests to which Exterior-type Douglas Fir Plywood is constantly subjected. We want to make sure that Exterior Plywood will withstand *all* water and weather conditions. We want to determine if there are possible ways of improving its performance.

These tests—important as they are—constitute but a small part of our extensive research program. We are seeking the answers to scores of problems *today* so that *tomorrow,* when all types and grades of Douglas Fir Plywood are again available everywhere, *this engineered lumber will be more useful to you than ever before.* Douglas Fir Plywood Assn., Tacoma, Wash.



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MADE LARGER, LIGHTER SPLIT-PROOF STRONGER

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EXT-DFPA—waterproof exterior type
PLYSCORD—utility sheathing grade
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"A PRODUCT OF AMERICA'S ETERNALLY REPLENISHING FORESTS"

vice-chairman, E. B. Doran, head, agricultural engineering department, Louisiana State University; *secretary,* P. T. Montfort, agricultural engineer, A. and M. College of Texas.

The Section is considering an invitation from the Southern Section for a joint meeting of the two sections to be held at the time of the annual convention of the Association of Southern Agricultural Workers at New Orleans in February 1943.

Personals of A.S.A.E. Members

Walter T. Ackerman recently accepted appointment as engineer in charge of construction and engineering in Region 1 of the Farm Security Administration. This region embraces all the New England states and part of New York. Prior to his appointment, Mr. Ackerman had served 16 years as head of the department of agricultural engineering at the University of New Hampshire.

J. Reid Bishop is now assistant engineer appraiser of the Federal Land Bank of St. Louis. He was formerly employed as a junior agricultural engineer in the U. S. Soil Conservation Service.

E K. Bonner, Jr. has recently taken a position in the engineering department of S. L. Allen Co., Philadelphia, manufacturers of a large line of farm machinery. Previously he held a similar position with the LeRoy Plow Co.

C. H. Christopherson and *Norton Ives,* members of the agricultural engineering staff at the University of Minnesota, are joint authors of Extension Bulletin 233, entitled "Painting on the Farm," recently issued by that institution.

(Personals continued on page 204)

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

William M. Adams, engineering dept., International Harvester Co. (Mail) East Moline, Ill.

Alfred E. Adkins, junior engineer, Tennessee Valley Authority, Knoxville, Tenn. (Mail) 1515 W. Cumberland Ave.

John T. Blakely, 220 Riverside Drive, Welch, W. Va.

Jack H. Brodie, RR No. 2, Nyssa, Ore.

James O. Dailey, 348 N. College St., Auburn, Ala.

Richard F. Dudley, junior agricultural aide, Soil Conservation Service, USDA. (Mail) RR No. 1, Cambria, Va.

Richard A. Duncan, 1st Lt., Corps of Engr., U. S. Army. (Mail) 1615 Alapai St., Honolulu, T. H.

Talcott W. Edminster, field engineer, Turner Construction Co. (Mail) Howland Rd., East Freetown, Mass.

Roger L. Ewart, RR No. 1, Box 333, E. Akron, Ohio.

Rene Guillou, research assistant, University of California, Davis, Calif. (Mail) Agricultural Engineering Bldg.

Robert M. James, cotton planter, Shelby, Miss.

William O. Jones, 2nd Lt., U. S. Army. (Mail) Snowdoun, Ala.

Howard O. McMillan, Jr., engineering aide, Tennessee Valley Authority. (Mail) 2212 Sheridan Ave., S., Minneapolis, Minn.

Walter M. Miller, farm manager, Tonganoxie, Kans.

Karl H. Norris, engineering draftsman, International Harvester Co. (Mail) 521 Wenonah Ave., Oak Park, Ill.

Sol D. Resnick, junior hydraulic engineer, Tennessee Valley Authority, Knoxville, Tenn.

Milo J. Salter, junior engineer, tractor div., Allis-Chalmers Mfg. Co. (Mail) RR No. 1, West Bend, Wis.

Hilton O. Thompson, engineering aide, Tennessee Valley Authority. (Mail) RR No. 3, Bernice, La.

Ing. Heliodoro V. Vasquez, Tonala 261, Mexico City, Mexico.

TRANSFER OF GRADE

Victor Richardson, soil rehabilitation engineer, farm management div., Union Central Life Insurance Co. (Mail) RR No. 1, Rocheport, Mo. (Junior to Member)

Because accidents interrupt output—

Greater Safety *means* Increased Production

Imperative Today!

Every accident brings not only a measurable loss in man-power and man-hours—but often an equally serious loss in equipment-hours as well. And anything that reduces the effectiveness of America's production machinery is a vital concern today.

For this reason, the greater safety of Atlas Manasite Detonators becomes more important, more desirable than ever.

Atlas Manasite Detonators offer greater resistance to impact and friction—an added margin of safety in case of inadvertent mishandling. While no blasting cap can be called "safe," Atlas Manasite Detonators make safety precautions not less important—but more effective.

Furthermore, the adoption of Atlas Manasite Detonators requires no time-consuming changes in operating technique. And since they cost no more, you get more for your money.

In these days, the real question is—Can you afford *not* to use Atlas Manasite Detonators?

MANASITE—Reg. U. S. Pat. Off.

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"Everything for Blasting"

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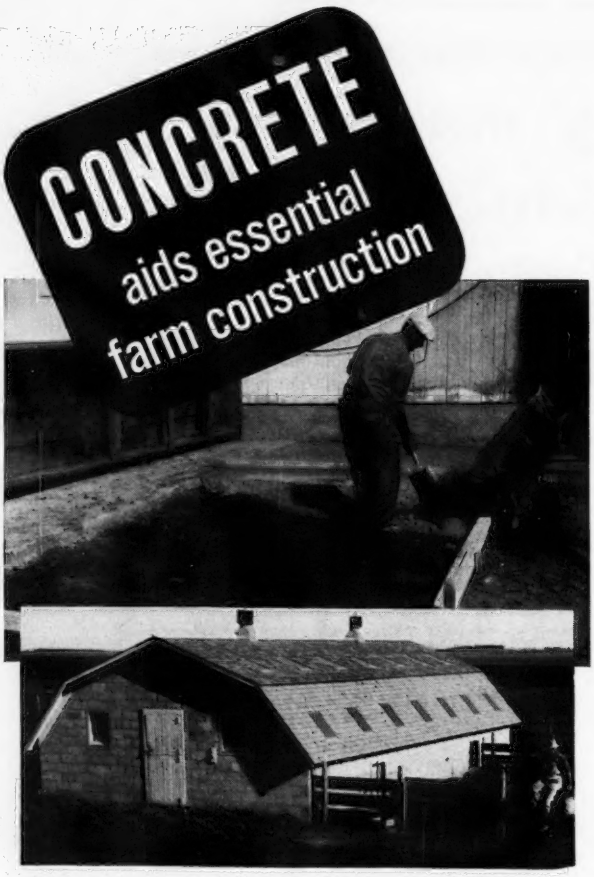


4 *timely considerations*

You'll find concrete helpful in developing designs for structures that aid wartime farm production—for these reasons:

- **Concrete imposes least burden on wartime transportation, since aggregates are locally available nearly everywhere.**
- **Critical materials are conserved—many concrete farm jobs need none.**
- **Fire and storm losses are minimized with concrete—doubly desirable in wartime, when every destroyed building represents a loss of urgently needed productive capacity.**
- **Concrete buildings meet all requirements for highest farm efficiency. Moderate in first cost they offer sanitation, comfort to animals, lifetime service with low maintenance.**

In recognition of war needs, the Portland Cement Association is preparing modified designs for many essential concrete farm structures, to eliminate or minimize the use of reinforcing steel. We will be glad to consult with you on farm building design and construction problems.

PORTLAND CEMENT ASSOCIATION
Dept. 6-1, 33 W. Grand Ave., Chicago, Ill.

BUY WAR SAVINGS STAMPS AND BONDS

Personals of A.S.A.E Members

(Continued from page 202)

Ray Crow, engineer, sales promotion division, Tennessee Coal, Iron and Railroad Company, is author of a booklet, entitled "Curing and Storing Grain on Southern Farms," just issued by his company, the purpose of which is to be of service in the storage of grain on individual farms or in small commercial or community storage projects. The booklet discusses in detail a simple and flexible low-cost system of construction for small grain containers ranging in capacity from 500 to 6000 bushels each.

John M. Ferguson and *J. W. Martin,* members of the agricultural engineering staff at Kansas State College, are joint authors of a timely mimeograph bulletin (Circular 43), entitled "Getting the Most from Your Tractor," recently issued by the Extension Service of that institution.

Geo. W. French has recently taken a position in the engineering department of the Skelly Oil Co., Eldorado, Kans.; he was formerly in the employ of the U. S. Soil Conservation Service.

Arlee C. Hanson is now rated as associate soil conservationist in the U. S. Soil Conservation Service, and his present position is that of district conservationist of the White Hall-Roodhouse Soil Conservation District and the Morgan County Soil Conservation District, located near White Hall, Ill.

J. B. Kelley, professor of agricultural engineering, University of Kentucky, is author of Circular 375, entitled "Repair and Adjustment of Mowing Machines," recently issued by that institution.

Robert J. McCall, beginning July 1, will be stationed at Pennsylvania State College in the capacity of extension agricultural engineer. Previous to this appointment he has been serving as instructor in agricultural engineering at Ohio State University.

R. P. Messenger who until recently has been chairman of the board of directors and general manager of the International Harvester Company of Australia, has recently returned to the United States to accept appointment as assistant to the vice-president of engineering in the farm equipment division of his company, with headquarters in the Chicago office.

V. S. Peterson has joined the agricultural extension division of E. I. du Pont de Nemours & Co., in the capacity of agricultural consultant. Previous to taking this position, he was extension agricultural engineer at Pennsylvania State College.

W. H. Tamm is now connected with the Engineers Corps, U. S. War Department. He has the rating of assistant engineer and is chief of the civil engineering section of the air field section. He was previously research assistant in agricultural engineering at the New Jersey Agricultural Experiment Station.

Student Branch News

WASHINGTON

THE A.S.A.E. Student Branch at Washington State College from May 1, 1941 to May 1, 1942 has been doing fine work in keeping the students interested in their school and in the department of agricultural engineering.

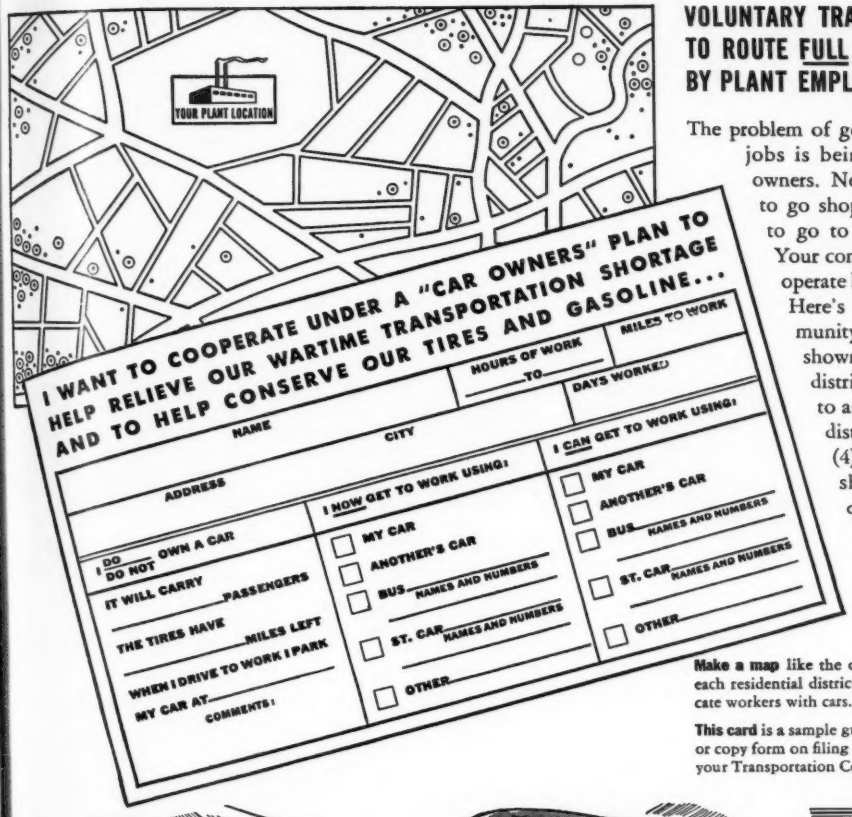
Headed by Elmer Neustel, as president the first semester, and George E. Miller the second semester this organization has been under sage and able guidance.

The ag engineers started out their activities by taking a two-day field trip on May 9 and 10 last year. This trip while leaving the agricultural field to a large extent, did much to broaden knowledge in other engineering fields. At 3 a.m. on May 9 we started for Burke, Idaho, which is about 150 miles from our campus at Pullman, and visited the Star Mine. In order to visit this mine, however, we descended 4000 ft by the usual miner's hoist, then boarded a train (open steel chair cars), and sped through a rock tunnel for two miles — our destination, the Star Mine.

In the mine at the 4000-ft level we again got into the hoist elevators and were raised to the 3700-ft level. From there we descended by ladder the 300 ft back to the 4000-ft depth and our starting point. During this climb down the ladders from one point to another, with a few slight detours, we were fortunate enough to see all of the mining operations, except blasting down the face of the stope, which is done between shifts when there are no men in the mine. Of the main problems in mining the importance of getting fresh air into the mine and extra water out were the easiest to comprehend.

By the same means used to get to the Star we journeyed back through the rock tunnel almost a mile *(Continued on page 206)*

MANY LARGE COMPANIES ARE NOW TAKING A CENSUS OF EMPLOYEES' CARS AS PART OF NATION'S PROGRAM TO GET 40,000,000 WORKERS TO THEIR JOBS ON TIME


YOUR PLANT LOCATION
I WANT TO COOPERATE UNDER A "CAR OWNERS" PLAN TO HELP RELIEVE OUR WARTIME TRANSPORTATION SHORTAGE AND TO HELP CONSERVE OUR TIRES AND GASOLINE...
NAME
CITY
ADDRESS
HOURS OF WORK
TO
MILES TO WORK
DAYS WORKED
I DO / DO NOT OWN A CAR
IT WILL CARRY ____PASSENGERS
THE TIRES HAVE ____MILES LEFT
WHEN I DRIVE TO WORK I PARK
MY CAR AT
COMMENTS:
I NOW GET TO WORK USING:
MY CAR
ANOTHER'S CAR
BUS NAMES AND NUMBERS
ST. CAR NAMES AND NUMBERS
OTHER
I CAN GET TO WORK USING:
MY CAR
ANOTHER'S CAR
BUS NAMES AND NUMBERS
ST. CAR NAMES AND NUMBERS
OTHER

VOLUNTARY TRANSPORTATION COMMITTEES TO ROUTE FULL CARS TO WORK ARE SET UP BY PLANT EMPLOYEES IN EACH COMMUNITY

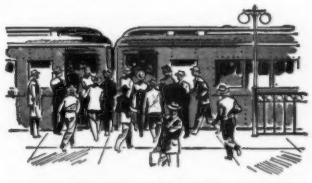
The problem of getting 40,000,000 workers to their jobs is being taken over by America's car owners. Neighbors are already doubling up to go shopping, to take children to school, to go to work . . . *but not enough of them!* Your company and your employees can cooperate by taking a census of workers' cars. Here's how you can do it in your community: (1) Fill out cards, like the one shown here, (2) Sort cards by residential districts, (3) Select sectional committees to act as traffic control groups for each district to assure equitable use of cars, (4) Route *full* cars to work on every shift. Details can be worked out quickly by you . . . your workers . . . your community. The important thing is to start today to get every last mile of use from our cars, our gas, our tires!

Make a map like the one above, on which to chart the routes for each residential district. Dots indicate workers' homes; circles indicate workers with cars.

This card is a sample guide. Make changes to suit your needs. Reprint or copy form on filing cards for each worker to fill out and turn in to your Transportation Committee.

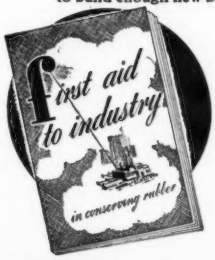
Trolleys can't do it ALONE. Even with staggered work hours to level off transportation peaks there aren't enough trolleys to take America's millions to work.

Buses can't do it ALONE. They're already taxed to their full seating capacity. And enough vital steel and rubber can't be spared to build enough new buses.

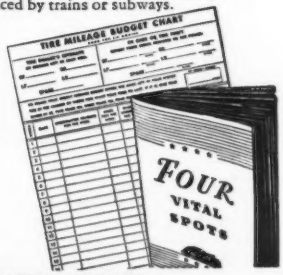


Trains can't do it ALONE. Although every railroad is cooperating 100%, many of America's mighty war production plants can't be serviced by trains or subways.

HOW TO CONSERVE MECHANICAL RUBBER GOODS
This 48-page book is for managers, engineers and plant operating men. It shows how you can conserve rubber through proper handling, installation and care of rubber conveyor, elevator and transmission belts; all types of industrial hose; packings; linings; rolls; mountings; and other mechanical rubber goods; and electrical wires, cables, and tapes. For free copies, write directly to Mechanical Goods Division, United States Rubber Company.



GET FREE MILEAGE BUDGET CHARTS
and copies of this free 32-page book on tire care from your local U. S. Tire Dealer or write direct to the United States Rubber Company. Hundreds of thousands of these charts and books are already in the hands of American car owners — helping to save tires, gas and oil.



IN AMERICA'S FIGHT FOR LIFE, EVERY TIRE-MILE MUST BE SAVED FOR ESSENTIAL DRIVING

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ON
EWC WHEELS
FOR ALL KINDS OF FARM MACHINERY
FOR over half a century, dependable EWC Wheels and Axles have helped keep the job rolling along. Today, when efficient speed is more important than ever, you'll find our engineering experience at your service — ready to render valuable aid in maintaining your "rolling stock" at peak performance. Write for Illustrated Bulletins describing our service on Wheels, Axles, or Mountings. (Rubber-tired wheels available on direct War Orders.)
EWC WHEELS
ELECTRIC WHEEL CO. Dept. AE Quincy, Illinois

STUDENT BRANCH NEWS

(Continued from page 204)

below the surface of the earth to the entrance of the Hecla Mine. Here we saw the enormous hoists powered by dual 800-hp electric motors used to raise the ore from the mine and also visited the concentrate mill where the ore from the mine is sorted and pulverized before shipment to the smelter. After visiting the concentrate plant, we left Burke which is the narrowest town in the United States, being located between two mountains which rise almost perpendicularly from the only street.

The next stop on our schedule was at Kellogg, Idaho, where we had the pleasure of visiting the Bunker Hill smelter. Here we saw them putting the concentrates from the mines into the smelters, roasting out the sulfides, and the rest of the operations which lead to the pouring of lead, zinc, and silver ingots.

As the day was not yet through we started for Spokane, Washington, and on the way visited the dam at Post Falls which is a water control and hydroelectric project. That evening we drove past the site of the now complete Gieger Field Airport, which is one of the newest in the Pacific Northwest.

The rest of the evening was spent in personal recreation, and next day we went through the Inland Empire Paper Co., and the Spokane Portland Cement Co., and spent a couple of hours at Felts Field, Spokane's airport. This completed our two-day trip except for the ride back to W.S.C.

Besides the A.S.A.E. trip almost every man went on others in various classes such as irrigation, land clearing, farm machinery, soil conservation engineering, and others.

For other activities, there was plenty for all to do in preparing lighting effects for the Harvest Ball, an annual semi-formal sponsored by the ags; erecting a prize-winning booth at the Little International Livestock Exposition; and decorating a portion of the walls in the men's gym for the Engineers' Ball. Another undertaking and a very pleasant one was being host to the A.S.A.E. Student Branch from the University of Idaho, which is located only 9 miles from here, at Moscow.

We had two delegates at the last A.S.A.E. Industry Seminar, and they reported lots of fun and much new information concerning the farm implement industry from sales to manufacturing.

The activities of the Washington Student Branch are largely of an educational nature; it is through the field trips and the speakers at our meetings that the members are given a fairly well-rounded picture of the practical side of the work for which they prepare themselves.

IOWA

Kenneth W. Snyder, Scribe

SPRING quarter has been a busy time for the A.S.A.E. Student Branch at Iowa State College. It started with an election of officers for the coming year. Those elected were Stanley Swanson, president; Quin Conard, vice-president; Clarence Bockhop, secretary; Gerald Kline, treasurer. Merril Crees was elected to the Engineering Council and Ray Armstrong to the Agricultural Council.

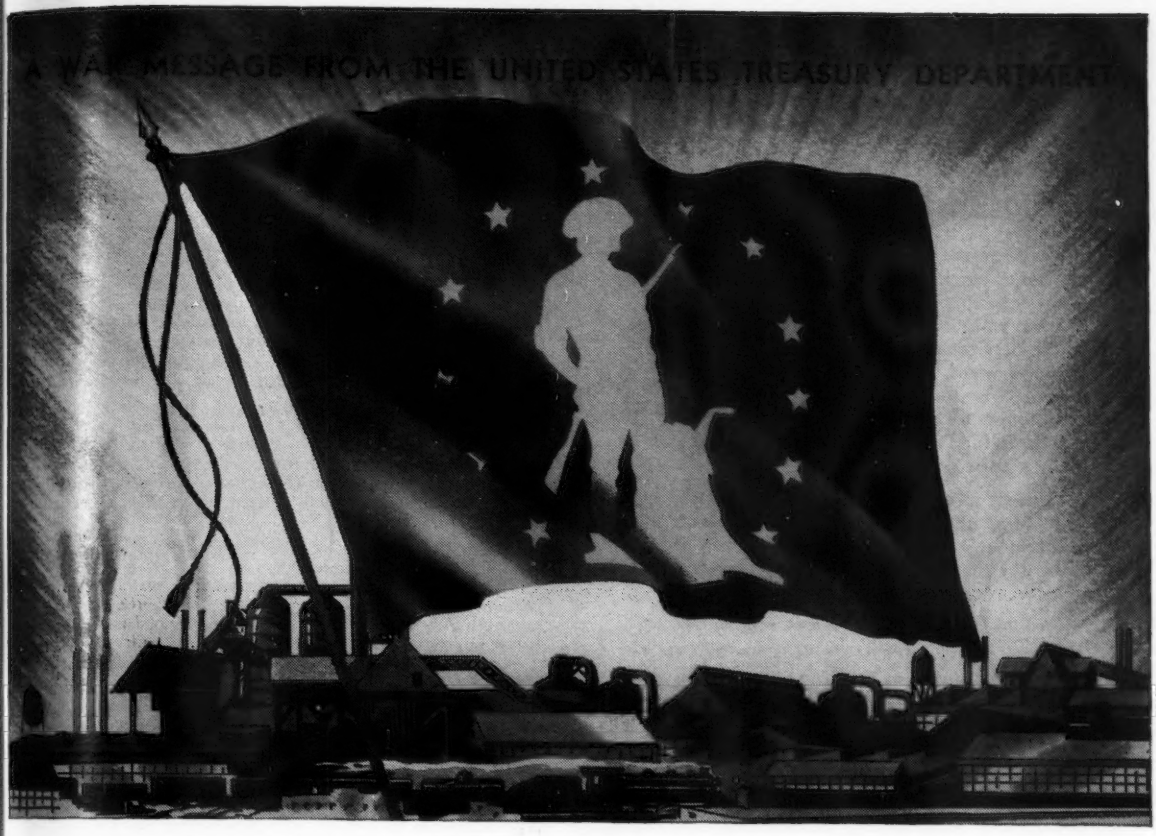
The big social event of the quarter was the annual spring picnic at Ledges State Park. Dale Woolsoncroft and his committee fed the students and faculty so well that there was almost no desire for the baseball game in the evening. It was so hard rounding up the picnickers when time came to go that their dates were almost late getting back to their dormitories.

The most important activity of the Branch during the quarter was the participation in Veishea. At this time most of the high schools close and the students come to see what Iowa State has to offer. Under the chairmanship of Dick Birney, the agricultural engineers put on a show of farm machinery, structures, and soil conservation that the high school students will long remember. Gerald Kline saw that the Branch was well represented in the parade.

At the last meeting of the quarter our Student Branch decided to hold some informal meetings during the summer. This is the first time in the history of the Branch that they have done this. The Branch also decided to send a large delegation to the A.S.A.E. annual meeting. So we'll see you in Milwaukee.

Proceedings of Hydrology Conference

THE papers presented at the Hydrology Conference held at State College, Pennsylvania, June 30 to July 2, 1941, have been compiled in a 6x9 publication designated Technical Bulletin No. 27 of the School of Engineering, Pennsylvania State College. Copies may be obtained from the College at a price of $2.00 each.



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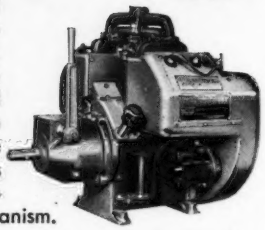

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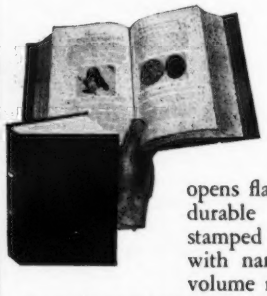

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EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

AGRICULTURAL ENGINEER wanted to fill position of assistant in full-time research work primarily in soil erosion control and farm machinery by a southern agricultural experiment station. The work will be on a 12-month basis, with 30-day vacation. Salary according to qualifications. While position is to fill vacancy due to war service, it is expected that it will become permanent. PO-138

AGRICULTURAL ENGINEER wanted to fill position open in northwestern university due to absence of staff member in military service. Work involves approximately half extension and half resident instruction. Major concentration in farm structures and soil and water conservation. Salary up to $3000 for qualified person. PO-137

AGRICULTURAL ENGINEERS wanted at southern institution. Extension agricultural engineer in farm buildings—a man who is qualified to design farm structures, preparing plans, etc. Beginning salary $1800 per year. Also instructor in agricultural engineering to handle courses in farm surveying and drainage, soil and water conservation, and related subjects. Needed by opening of summer quarter, June 23. Beginning salary $2000 per year. PO-136.

SALES ENGINEER wanted. Excellent opportunity offered for young agricultural engineer with good background in farm building construction. Work involves direct sales of building material to dealers, architects, contractors. Earnings equivalent of salary of $3000.00 a year or more and unusual possibilities for advancement with rapidly expanding organization. Applicants should indicate marital status, number of dependents, selective service classification, earnings expected. PO-135

CIVILIAN ENGINEERS. Due to expansion of activities, the Signal Corps of the U. S. Army is in need of civilian engineers who have specialized in engineering materials, metallurgy, or related fields. Interested engineers should apply in writing giving a full statement of their education and experience. Those selected will, on appointment, be given Civil Service ratings of P-2 or P-3 ($2600 or $3200 per annum) depending on their experience, and will be assigned to the Office of the Chief Signal Officer, Washington, D. C.

POSITIONS WANTED

AGRICULTURAL ENGINEER with B. S. degree in agricultural engineering from Iowa State College. Has four years' experience as engineer with the Soil Conservation Service and five years' experience as state agricultural conservation engineer for the Agricultural Adjustment Administration. Experienced both in engineering and administration. Thirty-two years of age, married, and have family. References upon request. PW-348

AGRICULTURAL ENGINEER with B. S. degree in engineering and M. S. degree in agricultural engineering. Experienced in college teaching, experiment station, and extension work; also factory and construction work. Especially qualified for college agricultural engineering, manufacturing, defense, construction, or trade extension work. Age above draft. PW-346

AGRICULTURAL ENGINEER with B.S. degree from midwestern college (1938) and M.S. degree from southern college (1940), desires employment with the Soil Conservation Service, in a defense industry, or in other engineering work. Has 1½ years' experience as engineer with the U. S. Soil Conservation Service in the South and in the Pacific Northwest. Familiar with agriculture in most parts of the United States. Civil Service rating as junior engineer. Eligible for reappointment. Age 35. Married. PW-345

AGRICULTURAL ENGINEER desires employment offering larger opportunity. Ten years' experience in the electric utility industry and two years' experience as an assistant extension agricultural engineer. Good farm background. Particularly qualified to handle all phases of rural electrification, pump irrigation, and farm machinery. Capable of planning and conducting educational or promotional activities. Holds a state professional engineering certificate. Thirty-six years of age. Married. References on request. PW-344